



**San Mateo Creek Basin Groundwater Site: Central Study Area  
Remedial Investigation/Feasibility Study  
Work Plan**

**FINAL**

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**San Mateo Creek Basin Central Study Area Working Group**



## Executive Summary

Groundwater within the Central Study Area (CSA) of the San Mateo Creek Basin (SMCB) in New Mexico is the subject of this Remedial Investigation/Feasibility Study (RI/FS) project. The objectives of the RI are to characterize groundwater present within the CSA by using groundwater flow, geological controls on groundwater movement, and groundwater quality to evaluate potential risks to human and ecological health and to develop remedial alternatives in the FS, if needed. The SMCB is approximately 80 miles west of Albuquerque. The southern boundary of the CSA is approximately 5.5 miles north of Milan, New Mexico, and within Cibola and McKinley Counties, and continues roughly 9 miles to the north to the intersection of New Mexico State Highway (NM) 509 and NM 605, a location referred to as the "Crossroads Area." The width of the CSA roughly follows the extent of saturated alluvial sediments (as defined by the U.S. Environmental Protection Agency (EPA) Phase 2 Report [EPA, 2018]) within a relatively narrow alluvial valley bounded to the west by bedrock shale and sandstone units and to the east by volcanic bedrock.

The current conditions within the CSA relative to groundwater movement and quality require better definition than is contained in prior studies by EPA and others to evaluate risks and the need for remedial action. Potential current sources of constituents to groundwater within the CSA that will be evaluated during this RI/FS consist of influxes at the boundaries of the CSA and two former mines within the CSA. Natural sources include the sediments of the alluvial system and bedrock materials, specifically naturally occurring minerals in the sediment and bedrock that contain constituents able to leach to groundwater.

This work plan describes the activities associated with the scoping, the RI, and the FS. A preliminary conceptual study area model was developed and is briefly described in this work plan in terms of its utility in identifying data gaps related to the understanding of current groundwater conditions. The data gaps were used to develop data quality objectives (DQOs). Six DQOs are presented that define the purpose of the proposed studies within the CSA. A phased approach to the field investigation includes the following activities:

- Phase 1 involves surface geophysics including electrical resistivity tomography and seismic reflection.
- Phase 2 involves the completion of boreholes in locations based on Phase 1 and aligned to satisfy DQOs 1, 2, 3, and 4 followed by construction of groundwater monitoring wells in the alluvial and bedrock systems.
- Phase 3 involves eight consecutive quarters of groundwater sampling to characterize water quality and constituent of potential concern distribution within the CSA including seasonal influences.

Background water quality conditions will also be evaluated as part of the assessment of current water quality conditions within the CSA. The results of the RI will be documented in a preliminary study area characterization report, which will be used to develop preliminary remedial action alternatives, remedial action objectives, and preliminary applicable or relevant and appropriate requirements, and upon which to base the completion of a human health risk assessment and a baseline ecological risk assessment problem formulations report. The need for treatability studies will continue to be evaluated throughout the project depending on the alternatives considered for any groundwater remediation, should it be required. The FS will be performed based on the outcome of the RI, and an evaluation of remedial alternatives will be completed as needed.

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## Acronyms and Abbreviations

|        |   |
|--------|---|
| °F     | Degree(s) Fahrenheit  |
| ARAR   | applicable or relevant and appropriate requirement                    |
| AOC    | Administrative Settlement Agreement and Order on Consent              |
| BERA   | baseline ecological risk assessment                                   |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COC    | constituent of concern  |
| COPC   | constituent of potential concern                                      |
| CSA    | Central Study Area  |
| CSM    | conceptual study area model   |
| DQO    | data quality objective  |
| EMNRD  | New Mexico Energy, Minerals and Natural Resources Department          |
| EPA    | U.S. Environmental Protection Agency                                  |
| ERA    | ecological risk assessment  |
| ERT    | electrical resistivity transect                                       |
| FS     | feasibility study   |
| FSP    | field sampling plan   |
| HMC    | Homestake Mining Company of California                                |
| HSU    | hydrostratigraphic unit   |
| NAVD88 | North American Vertical Datum of 1988                                 |
| NM     | New Mexico  |
| NMED   | New Mexico Environment Department                                     |
| PAL    | principle action level  |
| PRG    | preliminary remediation goal  |
| QAPP   | quality assurance project plan  |
| RAA    | remedial action alternative   |
| RAO    | remedial action objective   |
| RBSL   | risk-based screening level  |
| RI     | remedial investigation  |
| SAG    | San Andres-Glorieta   |
| SAP    | sampling and analysis plan  |
| SMCB   | San Mateo Creek Basin   |
| SOW    | Statement of Work   |
| UCL    | upper confidence limit  |
| UTL    | upper tolerance limit   |

# 1. Introduction

A groundwater remedial investigation (RI) and feasibility study (FS) will be performed in the Central Study Area (CSA) of the San Mateo Creek Basin (SMCB) Groundwater Site (hereinafter the "Site"). The CSA is an approximately 8-square-mile area comprised of saturated alluvial sediments underlain by multiple bedrock geological units some of which are water-bearing. The CSA is located in Cibola and McKinley Counties, New Mexico. The RI/FS will be performed according to an Administrative Settlement Agreement and Order on Consent (AOC) between the U.S. Environmental Protection Agency (EPA) and the Working Group (EPA, 2019a). The goals of the RI/FS are to:

- Define the nature and extent of constituents of potential concern (COPCs) in groundwater within the CSA.
- Evaluate the background water quality.
- Identify whether there is a risk to human or ecological health that would warrant groundwater remedial action.

If there is a risk that warrants groundwater remedial action, an FS report will be completed to evaluate remedial alternatives. This work plan is one of the documents required as part of the Statement of Work (SOW) detailed in the Settlement. These documents include the following:

- Preliminary conceptual study area model (CSM)
- RI/FS work plan
- Sampling and analysis plan (SAP), including a field sampling plan (FSP) and a quality assurance project plan (QAPP) (Jacobs, 2021a)
- Health and safety plan
- Identification of candidate technologies memorandum and treatability studies

The RI/FS work plan is the overarching document that describes the implementation strategy for the project with details provided in the other supporting documents. These documents are prepared during project scoping, which includes activities focused on collecting and assessing existing data from previous investigations and other work performed at the CSA. Project planning occurs during project scoping, and the documents detail the results of this planning effort. Planning documents dictate the work to be conducted in the RI and FS and will undergo EPA review and approval.

This work plan provides the proposed approach for the conduct of the RI/FS (project) with a focus on the sequence of tasks through the project scoping, RI, and FS.

An overview of the CSA including a summary of the preliminary CSM is provided under separate cover prepared during project scoping (Jacobs, 2021b). Data gaps identified in the preliminary CSM were used to develop the rationale for the RI/FS and data quality objectives (DQOs). The CSA management strategy is also presented in this work plan, followed by a description of the sequence of tasks and approach associated with each, with reference to supporting documents, where appropriate, for detailed information about field implementation, data collection and data quality assurance, interpretation, and feasibility analysis. The RI/FS will be performed according to an AOC between EPA and the Homestake Mining Company of California (HMC), Rio Algom Mining, LLC, and United Nuclear Corporation (collectively the "Working Group") (EPA, 2019a).

This work plan was prepared according to EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA, 1988) and Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA, 2006).

## 2. Site Background and Physical Setting

This section provides an overview of the background and physical setting of the CSA. A more detailed discussion is in the San Mateo Creek Basin Groundwater Site: Central Study Area Remedial Investigation/Feasibility Study, Preliminary Conceptual Study Area Model Technical Report (preliminary CSM report) (Jacobs, 2021b).

### 2.1 CSA Description

The CSA is located approximately 80 miles west of Albuquerque, New Mexico. The southern boundary is approximately 5.5 miles north of Milan, New Mexico (Figure 2-1). The CSA is within Cibola and McKinley Counties and is within the SMCB, which is part of the larger Rio San Jose drainage basin within the San Juan Basin. The CSA includes the San Mateo Creek alluvial groundwater and certain bedrock aquifers, with the southern boundary just north of the HMC Grants Reclamation Project beginning at groundwater monitor well P and continuing to the northern alluvial boundary wells (SMC-32 and SMC-26) (Figure 2-2). The northern boundary is in the vicinity of the intersection of New Mexico State Highway (NM) 509 and NM 605, a location referred to as the "Crossroads Area." NM 509 runs parallel to a surface water drainage feature in the northwestern portion of the CSA (Arroyo del Puerto), and NM 605 runs parallel to San Mateo Creek in the northeastern portion of the CSA. NM 605 continues south toward the HMC Grants Reclamation Project along San Mateo Creek. An area approximately mid-way through the CSA is referred to as "Sand Curve," where the roadway bends from a southwesterly direction to a southerly direction. This area is near the intersection between McKinley and Cibola Counties. The CSA is divided at this location with the Upper Area north of the county dividing line and the Lower Area south of this location, as per the AOC. The boundaries of the CSA on the east and west were drawn to include the estimated lateral extent of the saturated alluvial sediments.

Records indicate that uranium mining consisting of surface and underground operations occurred within the CSA boundaries from 1950 through 1981. Two former mines (Doris and Moe No. 4) are identified within the CSA boundary (Figure 2-3).

Moe No. 4 is a small underground mine situated on 3 acres located in the middle of the CSA to the east of San Mateo Creek. Moe No. 4 operated from 1959 through 1963 and consisted of a 30-degree incline with a wooden headframe (New Mexico Environment Department [NMED], 2011). As of 2011, the mine site still contained the decline (partially collapsed), a collapsed working, approximately 45 small mine materials piles (400 cubic yards), and the wooden headframe.

The Doris Mine is a small underground mine located in the northern section of the CSA to the west of San Mateo Creek. The mine operated between 1958 and 1981 (NMED, 2009). As of 2009, the mine site consisted of one open decline within a collapsing subsidence crater, one caved-in shaft, several mine materials piles, and an erosion protection berm (NMED, 2009).

The current land use within the CSA includes undeveloped land, rangeland for ranching, and fewer than a dozen private residences located adjacent to NM 605. Three residences are located near the southern end of the CSA, south of Sand Curve, and the remaining residences are located in the Crossroads Area where NM 605 and NM 509 intersect. Land ownership within the CSA includes private and government landowners. The U.S. Bureau of Land Management and State of New Mexico Land Office are the two government landowners, and property owned by the New Mexico Land Office is largely leased for agricultural purposes.

### 2.2 Topography, Climate, and Hydrology

The SMCB is located within the Colorado Plateau physiographic province in the northwestern corner of New Mexico. This province is characterized by relatively flat-lying, red, white, gray, green, and yellow sedimentary

rocks that have been eroded to form mesas, buttes, and badlands. Mesas within the SMCB generally have relief ranging from approximately 500 to nearly 1,000 feet. Mount Taylor is the most significant topographic feature in the SMCB, with an elevation of approximately 10,500 feet North American Vertical Datum of 1988 (NAVD88). Topography within the CSA is relatively flat, ranging in elevation from approximately 6,600 feet NAVD88 near the southern boundary to approximately 6,900 feet NAVD88 north of the Crossroads area (a gradient of approximately 0.007 foot per foot).

The SMCB is located in an arid climate zone, with an aridity index (mean annual precipitation [1977–2020, 10.21 inches]) divided by mean annual potential evapotranspiration (1977–2020, 55.83 inches) of 0.18 (Utah Climate Center, 2020). The majority of annual rainfall (60 percent) occurs between July and October with approximately 0.5 inch of precipitation per month for the remainder of the year on average. Temperatures in the region are fairly mild, averaging approximately 52 degrees Fahrenheit (°F) annually and ranging from approximately 33°F during winter months to approximately 70°F during summer months.

Although smaller tributary streams and springs are present, the primary surface drainages in the SMCB include San Mateo Creek and Arroyo del Puerto (Figure 2-2). The headwaters of San Mateo Creek originate on the northwest flank of Mount Taylor, approximately 10 miles east of the CSA. As the creek flows west along NM 605, several small tributaries discharge to the stream. Arroyo del Puerto, an ephemeral stream, originates in the Ambrosia Lake area, northwest of the CSA. The confluence between San Mateo Creek and Arroyo del Puerto is located downstream of the Crossroads Area. The San Mateo Creek channel continues to the south/southwest toward the confluence with the Rio San Jose. Although the stream is typically perennial in its upper reaches (north of San Mateo), streamflow generally infiltrates into the subsurface south of the Crossroads area with surface flow rarely reaching Rio San Jose (Brod, 1979).

## 2.3 Geology

Regionally, the SMCB is in the southern portion of the San Juan structural basin, which encompasses parts of New Mexico, Colorado, Arizona, and Utah, with an area of 21,600 square miles (Craig, 2001). The CSA is located at the intersection of three regional tectonic features: the Chaco Slope, the Zuni Uplift, and the Acoma Embayment. The Zuni Uplift, west and southwest of the CSA, consists of a northwest trending monoclinical fold that is responsible for the regional dip of the bedrock units (to the northeast) beneath the CSA. Bedrock ranges in age from Permian to Cretaceous, and at the northern portion of the Lower Area, the bedrock system transitions from Jurassic-age sandstones to the Triassic-age Chinle formation, with the Upper, Middle, and Lower Chinle sandstone aquifers separated by shale units beneath the alluvial sediments. An east and west fault zone border intersects the Chinle units toward the southern end of the CSA. Figure 2-4 and Figure-2-5 present a geologic map and stratigraphic column for the SMCB. Bedrock underlying the CSA consists of (from oldest to youngest):

- The Permian age Glorieta Sandstone and San Andres Limestone
- Moenkopi Formation: Triassic age interbedded sandstone, siltstone, and conglomerate with some slope-forming mudstone
- Chinle Group: Triassic age shales, mudstone, sandstone, and limestone
- Wingate Sandstone: Late Triassic and Early Jurassic age sandstone
- San Raphael Group (Entrada Complex): Jurassic age alternating units of shale, sandstone, and limestone
- Morrison Formation: Jurassic age interbedded claystone, siltstone, mudstone, sandstone, and some thin limestone beds. This formation is the primary source of uranium ore in the district.
- Dakota Sandstone: Cretaceous age
- Mancos Shale: Cretaceous age

The San Juan Structural Basin is a heavily faulted region, containing many typically normal faults with around 40 feet of displacement (Brod, 1979). The primary fault within the CSA is the San Mateo fault zone, extending northeast from the Zuni Uplift, crossing NM 605 southwest of the Crossroads Area and ending at San Mateo Mesa. The San Mateo fault is a northeast trending normal fault with a maximum displacement estimated at 450 feet (Brod and Stone, 1981). Differing interpretations regarding the nature of the fault zone (EPA, 2018; HMC, 2019) result in uncertainties regarding the hydraulic characteristics of the structure(s) and their role in movement of groundwater and COPC migration within the CSA. Figures 2-6 through 2-11 present cross sections through the CSA, illustrating the interpretations included in the EPA Phase 2 Report (EPA, 2018) and the Leapfrog (Seequent) model (HMC, 2019). Cross section locations are presented on Figure 2-4. Figure 2-6 and Figure 2-7 present northeast/southwest trending cross sections roughly paralleling San Mateo Creek. A comparison of the cross sections highlights the differing interpretations of fault structures. For example, the interpretation of the fault northeast of well R included in the EPA Phase 2 report shows sufficient displacement such that the San Rafael Group is in contact with the Chinle Group (Figure 2-6). The interpretation included in the Leapfrog model suggests less displacement such that the Chinle Group is present on both sides of the structure (Figure 2-7). The Dos Lomas Quadrangle (Cather, 2011) is better aligned with the interpretation presented in the Leapfrog model, suggesting a smaller displacement than the interpretation presented by the EPA Phase 2 report. Differing interpretations for the number and displacement on faults farther northeast are also apparent.

Figures 2-8 and 2-9 present interpretations of subsurface conditions along a roughly east/west trending section line near the southern portion of the CSA. These figures illustrate differing interpretations with respect to both the geometry of the alluvial deposits (which impact estimates of underflow in the shallow groundwater system) and fault movement. Figures 2-10 and 2-11 present interpretations of geology and structure along a roughly east/west trending section line in the northern portion of the CSA. These figures illustrate differing interpretations of the orientation of bedding as well as the number, location, and displacement along fault structures. Figure 2-11 shows an upward movement in the east block. This graphical representation of geology and geological structures is inconsistent with existing published interpretations and demonstrates that uncertainties in the current depiction exist due to the scale and resolution at which the 3D Leapfrog model was produced. The Leapfrog model is subject to revision through the RI/FS work. As discussed further in Section 5, an understanding of the characteristics of geologic units and structural features is integral to the CSM for groundwater flow and COPC movement, which is a primary focus of RI/FS field efforts.

Bedrock uplift, followed by subsequent periods of volcanism and erosional/depositional periods, has resulted in the presence of Quaternary age unconsolidated deposits exceeding 100 feet in thickness in portions of the CSA. Basal valley alluvium generally contains the coarser sands and gravels, while the upper alluvium is composed predominantly of silt and fine sands (Gordon, 1961). Using lithology data from boreholes and wells, the EPA produced a base of alluvium structure map to approximate the distribution of alluvial deposits in and around a majority of the CSA (EPA, 2018). The base of the alluvium appears to be deepest near where ancestral streamflow occurred and becomes higher with increasing distance from the ancestral incised channel. Lithologic data were later incorporated into a Leapfrog model of the SMCB, yielding an alternate interpretation of the distribution of deposits (HMC, 2019). Figures 2-12 and 2-13 present a comparison of the extent and thickness of alluvial deposits between the EPA Phase 2 Report and the Leapfrog model along section lines transverse to the alluvial valley in the northern and southern portions of the CSA, respectively. Profile locations are presented on Figure 2-14. Uncertainties about the geometry of the alluvial system result in subsequent uncertainties for groundwater flow and COPC transport in the shallow groundwater system. As discussed in Section 5, RI/FS field efforts will provide data to refine the characterization of the aquifer system.

## 2.4 Hydrogeology

As discussed in the preliminary CSM report (Jacobs, 2021b), the occurrence and flow of groundwater within the bedrock units underlying the CSA are not well understood, given the relatively few bedrock wells and limited groundwater elevation dataset. Although regionally, there are wells that produce groundwater from many of the

bedrock units described above; the units that act primarily as aquifers include the Glorieta Sandstone and the San Andres Limestone (collectively forming the San Andres-Glorieta (SAG) aquifer), the Westwater Canyon Member of the Morrison Formation, the Dakota Sandstone, and the sandstone units of the Chinle Formation. Of these aquifers, groundwater within the Westwater Canyon and Dakota sandstone likely flow to the northeast (down dip) and eventually leaves the study area at depth.

The SAG is the major regional aquifer in western New Mexico and eastern Arizona (Brod and Stone, 1981). The SAG aquifer is under confined conditions and in the CSA is under artesian pressure due to the significant difference in elevation between the formation's outcrops and the SMCB (Cooper and John, 1968) and the presence of the overlying, predominantly fine-grained Chinle Group. Groundwater in the SAG aquifer flows outward from the recharge/outcrop area at Zuni uplift to the north/northeast. Groundwater within the SAG aquifer is discharged through the pumping of wells, spring discharge in southwestern McKinley County, and evapotranspiration and leakage to adjacent units.

The Westwater Canyon Member is a persistent aquifer, where saturated, and has been used as such within the CSA, where wells tap the formation. Groundwater in the Westwater Canyon Member has been shown to move to the northeast, down dip, but natural discharge points are unknown (Cooper and John, 1968). Westwater Canyon Member well yields in excess of 20 gallons per minute have been reported; however, there is uncertainty with previous estimates as more recent work has suggested that wells previously reported as being completed in the Westwater Canyon Member may be completed in the Dakota Sandstone. This uncertainty is related to the existence and extent of a suggested down-dropped structural graben in the San Mateo Fault Complex as depicted by EPA. Refining knowledge of this fault zone and its effects on the movement of groundwater is a goal of this RI. Wells completed in the Dakota Sandstone are primarily for livestock or domestic use (Brod, 1979). Recharge to the Dakota Sandstone occurs through precipitation on outcrops and downward percolation of water in subcrop areas beneath saturated alluvium and potentially through fault zones, and natural discharge points are unknown.

Groundwater in the alluvial aquifer system generally exists under unconfined conditions within the CSA, although semiconfined to confined conditions occur in other portions of the SMCB where basalt flow and/or fine-grained lacustrine deposits are present. The alluvial aquifer system within the CSA is recharged primarily through deep percolation of precipitation and stream infiltration and groundwater underflow. Groundwater in the alluvial aquifer system generally follows surface water drainage channels, flowing to the south/southwest within the CSA (Figure 2-14). Alluvial groundwater leaves the CSA through groundwater underflow, seepage to underlying bedrock units, and discharge to wells.

## 2.5 Groundwater Quality and Geochemistry

The alluvial groundwater within the CSA contains sodium and calcium as the dominant cations and bicarbonate, sulfate and chloride as the dominant anions. The average, median, standard deviation, and range of major ion and trace elements are summarized in Table 2-1 (these average concentrations show the range of groundwater chemistry within the CSA along with COPCs uranium and selenium and are based on data from 2009 to 2019)(EPA, 2018 and HMC, 2020) with more details provided in the preliminary CSM report (Jacobs, 2021b):

The preliminary CSM compared the concentrations of constituents in groundwater at available groundwater monitoring well locations within the CSA to principle action levels (PALs) based on federal drinking water standards (EPA) and State of New Mexico (NMED) groundwater protection standards. Constituents in alluvial and/or bedrock groundwater that exceeded these standards based on available data include the following: uranium, selenium, total radium (Ra-226 + Ra-228), sulfate, chloride, nitrate, and total dissolved solids. This initial screening of constituents that exceed PALs was performed to identify COPCs for evaluation during the RI/FS and to be incorporated in the SAP to guide the groundwater and sediment sampling and analysis program. PALs were used in the absence of available information about background water quality. An objective of the field

investigation will be to evaluate background water quality to use as a basis for evaluating constituent concentrations in alluvial and bedrock groundwater.

The major ion and trace element composition of the groundwater in the CSA is partially dictated by the interaction of natural groundwater recharge with naturally occurring minerals within the alluvial sediments and bedrock units; much of the alluvial sediments is comprised of weathered bedrock materials that are the source of the Quaternary alluvial material within the CSA. Bedrock within the CSA contains uranium and selenium disseminated throughout the various Jurassic and Cretaceous-age units and in elevated concentrations to constitute ore bodies within the Jurassic bedrock. A significant aspect of the project RI will be to differentiate constituents and concentrations in groundwater due to dissolution from these mineral phases from those present in groundwater due to other current sources within the CSA; the plan for this evaluation is described in the FSP, Section 4.2.

## 3. Initial Evaluation

### 3.1 Preliminary Conceptual Exposure Model for the CSA Groundwater

The sections below summarize key points in the preliminary CSM report (Jacobs, 2021b).

#### 3.1.1 Conceptual Exposure Model Overview

Conceptual exposure models describe the potential exposure scenarios and pathways through which humans and wildlife (ecological receptors) may be exposed to groundwater contaminants. Conceptual exposure models take into consideration information on sources of COPCs, release mechanisms, routes of migration, potential exposure points, potential routes of exposure (the means by which a COPC reaches a receptor), and potential receptor groups.

An exposure pathway is the physical course that a COPC takes from the point of release to a receptor. For an exposure pathway to be complete, the following components must be present:

- A source that results in a release of a COPC to the environment
- A mechanism of COPC transport
- An exposure media (that is, groundwater)
- An exposure route
- A receptor or group of receptors

In the absence of any one of these components, an exposure pathway is considered incomplete and therefore presents no hazard and poses no risk. In other cases, limits to any of these components of the conceptual exposure model can limit risk. Potential exposure pathways are discussed in Section 3.2.

#### 3.1.2 Current Sources and Potential Transport of COPCs

Current sources to the CSA include groundwater influx at the boundaries of the CSA, minerals within the alluvial sediments and bedrock matrix, and the former mines within the CSA (Doris and Moe No. 4). These former uranium mines within the CSA may release COPCs, including radionuclides and metals, to groundwater.

The preliminary CSM report (Jacobs, 2021b, Table 6-2) includes estimates of potential groundwater underflow into the CSA from the Upper San Mateo Creek and Arroyo del Puerto alluvial channels. Estimated underflow into the CSA may range from approximately 8,000 to 84,000 gallons per day depending on the horizontal hydraulic conductivity of alluvial materials and geometry of alluvial deposits (Figure 2-12). The potential for additional groundwater inflow to the CSA from Poison Canyon and lateral tributary channels in the Lower Study Area will be further evaluated through field data collection and groundwater modeling as part of the RI report effort.

Within the CSA, COPCs in the alluvial groundwater system would be transported to the southwest (Figure 2-14). Estimated linear groundwater velocities in the alluvial aquifer, computed based on a horizontal hydraulic conductivity of 25 feet per day, range from approximately 0.5 to 2 feet per day. The potential for vertical migration of COPCs from the alluvial aquifer to the underlying bedrock aquifer system exists (particularly given the presence of subcrops and faults); however, there is a lack of data within the CSA with which to quantify the location and magnitude of vertical groundwater flow.

Although groundwater quality samples have been collected from bedrock wells within the CSA, recent groundwater level data (along with contemporaneous measurements in adjacent alluvial aquifer wells) is not available. A high degree of uncertainty exists regarding potential transport of COPCs in the bedrock groundwater system. As discussed in Section 2, groundwater flow directions (based on limited data) in the bedrock aquifer

systems appear to be in the down dip direction to the northeast. Depending on the hydraulic characteristics of the fault zone, structural features have the potential to facilitate groundwater movement (and COPC transport) both vertically and in a direction counter to inferred regional flow (to the southwest).

Field activities included in this RI/FS Work Plan and subsequent numerical groundwater flow modeling will provide information to refine the understanding of primary and secondary COPC sources and transport pathways. These data will be used in future updates to the CSM.

## **3.2 Preliminary Identification of Response Objectives and RAAs**

Preliminary response objectives or preliminary remedial action objectives (RAOs) consist of medium specific goals for protecting human health and the environment. RAOs specify the contaminants and media of interest, exposure pathways, and preliminary remediation goals (PRGs) that permit a range of treatment and containment options to be developed. Preliminary RAOs are based on the information from the preliminary CSM report (Jacobs, 2021b).

### **3.2.1 Summary of CSM Information for Preliminary RAO Development**

The CSM information described in the sections below will be used to develop preliminary RAOs.

#### **3.2.1.1 Current and Reasonably Anticipated Future Land Use**

Current land use in the CSA includes undeveloped land, rangeland for ranching, and fewer than a dozen private residences. A portion of the property is owned by the New Mexico Land Office, which leases these lands for agricultural purposes. These land uses are expected to continue in the foreseeable future. Based on this information, the CSM identified the resident rancher, recreational user (visitor), and trespasser as potential human receptors of groundwater.

#### **3.2.1.2 Constituents of Potential Concern and Media of Interest**

The preliminary CSM identified radionuclides and inorganic constituents as COPCs in groundwater. Analytes evaluated in groundwater include uranium, selenium, radium 226+228, sulfate, chloride, nitrate, and total dissolved solids.

### **3.2.2 Potential Human Receptors and Exposure Pathways**

Potential human receptors are ranchers and other residents living within or near the CSA and short-term visitors or trespassers. Ranchers and other residents may be exposed to constituents if impacted groundwater is used as residential tap water (that is, ingestion, dermal contact, and inhalation exposure) or as irrigation for homegrown produce and/or livestock.

Risks to potential receptors were identified as data gaps in the CSM. Risks to potential receptors will be evaluated in the baseline human health risk assessment (HHRA).

#### **3.2.2.1 Potential Ecological Receptors and Exposure Pathways**

The preliminary CSM identifies near surface mine features within the CSA that may have associated COPCs that may migrate to groundwater. The preliminary hydrogeological conceptual model indicates that groundwater is not in hydraulic communication with adjacent surface water features. Transport mechanisms to environmental media and subsequent exposure pathways to ecological receptors are therefore not complete. A baseline ecological risk assessment (BERA) problem formulation report will be prepared; however, it is likely that there is no complete pathway from groundwater to ecological receptors.

The potential hydrogeological connection from groundwater to surface water will be further examined during the RI to determine whether the ecological risk assessment (ERA) needs to proceed beyond the development of the CSM and preparation of the problem formulation report to a screening level ERA and subsequent steps to complete the ERA. If a pathway from groundwater to ecological receptors is identified, the ERA steps following the Problem Formulation will be conducted in accordance with the requirements of Section 7(b) of the SOW.

### 3.2.3 Preliminary Remediation Goals

Insufficient information currently exists to identify PRGs.

PRGs are developed when chemical-specific applicable or relevant and appropriate requirements (ARARs), site characteristic data, and information from the human health and ERAs become available. As outlined in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988), before PRGs are finalized, contaminant levels in each media will be compared to the PRGs and evaluated against the following factors:

- Whether the remediation goals for all carcinogens of concern, including those with goals set at the chemical-specific ARAR level, are protective within the incremental cancer risk range of  $10^{-4}$  to  $10^{-6}$ .
- Whether the remediation goals set for all non-carcinogens of concern including those with goals set at the chemical-specific ARAR level, are sufficiently protective at the Site (i.e., non-cancer index threshold of 1).
- Whether environmental effects (in addition to human health effects) are adequately addressed.
- Whether the exposure analysis conducted as part of the risk assessment adequately addresses each significant pathway of human exposure identified in the baseline risk assessment.

PRGs will be developed during the RI.

### 3.2.4 Preliminary RAOs

Based on the CSM information, the following preliminary RAO has been identified:

- RAO 1: Human Health Exposure to Groundwater:
  - Prevent ingestion of water having constituents of concern (COCs) at concentrations above background for the CSA and above a total excess cancer risk range of  $10^{-4}$  to  $10^{-6}$ , the State's excess cancer risk threshold of  $10^{-5}$ , and a non-cancer hazard index of 1.

Preliminary RAOs will be refined as additional information is obtained and analyzed during the RI process. A refined list of preliminary RAOs will be provided no later than when the Preliminary Study Area Characterization Report is submitted.

### 3.2.5 Preliminary RAAs

Insufficient information is currently available to definitively identify a preliminary range of remedial action alternatives (RAAs) and associated technologies. An initial technology assessment was prepared that identifies conceptual RAAs associated with water treatment; however, this does not describe the full range of RAAs that may be identified during the FS (Jacobs, 2021c). Preliminary RAAs will be provided no later than when the Preliminary Study Area Characterization Report is submitted.

### 3.2.6 RI Process to Develop RAOs, and Preliminary RAAs, and ARARs

Preliminary RAOs will be refined throughout the RI as data gaps identified in the preliminary CSM are understood. Preliminary RAAs, RAOs, and ARARs will be submitted to EPA at the same time as the Preliminary Study Area Characterization Report for review, comment, and approval, and these will be refined as risk to

receptors and COCs are identified in the HHRAs; preliminary chemical- and location-specific ARARs and to be considered criteria are refined; and PRGs are developed. Potential chemical- and location-specific ARARs and to be considered criteria, and PRGs will be included in the RI report. Refined RAOs will be recommended at the conclusion of the RI and will support selection of remediation criteria for the site.

General response actions for groundwater defining institutional controls, containment, treatment, excavation, pumping, or other actions, singly or in combination, that may be taken to satisfy the RAOs for the site will be developed and evaluated as additional site information is understood (including the initial determination of areas or volumes of groundwater that require an action) and RAOs are refined. General response actions will be included in the RI report.

### **3.2.7 Feasibility Study Process to Identify, Screen, and Evaluate RAAs**

Once additional site information is obtained and analyzed, RAAs will be identified and evaluated against nine evaluation criteria as defined and required in the National Contingency Plan. Section 5.9 provides details about the FS process to identify, screen, and evaluate remedial alternatives.

## 4. Work Plan Rationale

The activities associated with the RI are directed at filling data gaps identified in the preliminary CSM. New data are required to fill these data gaps, and these data will be obtained from field investigation activities. In addition, existing data will be reviewed further during the RI, as well as prior interpretations, to assist in refining the preliminary CSM. The data will be used for the risk assessment and remedial alternatives evaluation, with DQOs that are directed at obtaining information to complete these activities, presented here.

### 4.1 Statement of the Problem(s) Posed by the CSA

The data gaps associated with the preliminary CSM must be addressed to evaluate the human health and ecological risks associated with groundwater and to develop and assess alternatives capable of mitigating these risks. The data gaps are the drivers for the DQOs, and the data gaps have been formulated into six problem statements. These problem statements are associated with evaluating the presence and movement of COPCs in groundwater in the CSA and are also associated with understanding risks and groundwater management alternatives. The problem statements are as follows:

1. **Hydrogeology of the CSA:** The lithologic and hydraulic properties of the alluvial sediments and bedrock aquifers, in terms of the distribution and occurrence of gravel, sand, silt, clay, and fractures in bedrock, and resultant hydraulic conductivity distribution and storage properties, and vertical gradients, requires better definition, specifically at locations within the CSA important for groundwater and constituent movement. Groundwater that moves through higher permeability flow paths in the sediments and bedrock, and vertically from the alluvial sediments to bedrock, will potentially transit the CSA more rapidly and distribute COPCs through the CSA.
2. **Role of the San Mateo Fault Zone in Groundwater Movement in the CSA:** Geologic structures along the San Mateo Fault Zone within bedrock cause offsets in the contacts between individual bedrock water-bearing units and affect the contacts between the alluvial sediments and individual bedrock units. These structures are not currently understood in sufficient detail at locations critical for understanding groundwater movement across the CSA, and they will influence groundwater and COPC distribution across the CSA. This data need is specific to the role that the San Mateo Fault Zone plays in influencing groundwater movement.
3. **Background Groundwater Conditions:** The water quality associated with groundwater in the saturated alluvial sediments and bedrock aquifers is currently not well known within the CSA; a better understanding of background water quality is needed to evaluate the concentration of constituents present within the CSA due to background conditions.
4. **Geochemistry of the CSA:** COPC distribution in groundwater across the CSA was last estimated in 2016 with a limited data set. The distribution of constituents and their concentration trends with time is not adequately understood in terms of the basis for the current distribution and trends in concentration; this includes the transport properties of COPCs in groundwater through the CSA. This data gap exists for COPCs both in saturated alluvial sediments and in bedrock groundwater.
5. **Risk Assessment of Groundwater:** Groundwater within the CSA potentially contains constituents at concentrations above background that present a risk to human and ecological health.
6. **FS of Groundwater Alternatives:** Remedial actions may be necessary if groundwater is found to contain constituents at concentrations above background that may pose a risk to human health and ecological health.

These six problem statements are the basis for DOQs described in the sections below.

## 4.2 Data Quality Objective Needs

The DQOs were developed following EPA's seven-step iterative process, as shown on Figure 4-1. Formulation of the problem statement is the first step (as described in Section 4.1). All problems, borne out of data gaps in the preliminary CSM, are problems of "estimation," (for example, ascertaining the mean concentration level of a constituent in the groundwater system or determining the hydrogeological or geological properties within the CSA).

Estimation problems are different than "decision" problems in terms of Step 6. In Step 6, the performance or acceptance criteria associated with the analytic approach is specified; for decision problems, this requires hypothesis formulation and an investigation approach that limits false rejection and false acceptance errors. Estimation problems require that in Step 6 performance criteria be described such that a determination about data usability can be made. Data usability often requires professional judgment; other times, the data usability can be evaluated using statistical tools associated with variance of a parameter (such as mean concentration data) and an assessment of this variability for data to be usable within the context of estimating the physical characteristics of the system.

The DQOs all inform the QAPP, and the QAPP describes the quality assurance process such that the data obtained to estimate specific properties of the CSA are of the appropriate quality to arrive at a usable estimate of physical properties of the CSA.

The DQOs are presented in Tables 4-1 to 4-6. Each DQO is discussed in the sections below.

### 4.2.1 DQO 1: Hydrogeology of the CSA

DQO 1, presented in Table 4-1, is as follows: "Within the CSA, characterize the hydrogeological properties of the alluvial sediments and bedrock aquifers to identify the principal groundwater flow paths, flow rates, and vertical hydraulic gradients between the saturated alluvial sediments and bedrock systems."

Goal: The study goal associated with DQO 1 is to estimate the hydrogeological properties of the CSA as they relate to the principal groundwater flow paths and to characterize the nature and magnitude of the vertical gradients that exist between the alluvial sediments and bedrock units. Final locations for monitoring wells, including well clusters, will be selected based, in part, on geophysical profile data. The bedrock units that will be instrumented as part of the monitoring network will primarily be units that are sub-cropping into the alluvium at these final selected monitoring well locations.

Information Inputs: Information will be obtained to satisfy this DQO using the following approaches:

- Groundwater elevation data
- Surface geophysics (electrical resistivity transect [ERT] and seismic reflection) for determining lithologic variability over large (hundreds of feet) scales.
- Borehole drilling, including drilling methodology
- Borehole geophysics, cores, and drill cuttings for determining lithologic variability over small (2- to 5-foot) scales along with the frequency and aperture of fractures present within the bedrock formations
- Borehole geophysics, lithologic cores, and cuttings to identify depths to the base of the alluvium and tops of bedrock formations for preparation of lithological boring logs and detailed mapping of structure
- Aquifer tests to evaluate hydraulic conductivity and storage properties of alluvial sediments and bulk bedrock units
- Packer tests to evaluate hydraulic conductivity of individual bedrock fracture zones

- Sediment analysis to evaluate particle sizes
- Available information about existing wells and associated lithologic logs

Scope/Analytic Approach: Information will be obtained from the field investigation to satisfy DQO 1. Surface geophysical methods (ERT and seismic reflection) and existing information from wells located in the CSA will provide data upon which to make informed decisions about placement of boreholes within the CSA for further hydrogeological characterization of the alluvial and bedrock systems. Three key locations will be targeted for the geophysics work, including the northern portion of the Upper CSA (the Crossroad Area), where multiple surface drainage features exist (Arroyo del Puerto and San Mateo Creek and the unnamed tributary that runs between these) and also where the bedrock fault system may be more complex and may influence groundwater movement. Geophysics work will be performed on the west side of the Upper CSA at the interface with Poison Canyon and across the broader alluvial channel in the lower CSA. Boreholes will be completed to varying depths to obtain lithological information from the alluvium and bedrock materials to evaluate the groundwater depth and provide information about aquifer physical properties (through lithological logging, soil sampling and analysis, and borehole geophysics). Groundwater wells will be completed at select locations based on the presence of groundwater, alluvial and bedrock lithological variation and type, and location within the CSA and prior inferred groundwater flow paths. Aquifer tests will provide information about hydraulic conductivity, and soil/sediment analyses will provide particle size information (to quantitatively classify lithologic units [gravel/sand/silt/clay] within specific boreholes). Additional details are provided in Section 5.2.1 and in the FSP. Finally, a numerical groundwater model will be assembled using the data obtained from this work. The purpose of this model will be to evaluate groundwater exposure pathways and to simulate groundwater and constituent migration and to aid in the development of remedial alternatives if needed. Groundwater modeling will also be used to improve understanding of the CSA site water balance including the quantity of groundwater recharge entering the aquifer system through variably saturated flow.

Acceptance Criteria and Plan: Given that DQO 1 is directed at estimating hydrogeological properties of the CSA, the performance criteria rely on a non-statistical, professional judgement based approach with hydrogeology, geophysics, and geology subject matter experts responsible for directing and interpreting the data obtained to satisfy DQO 1. The majority of the field work planned for the RI is associated with DQO 1; the geophysics data obtained initially will be used as a guide to select locations for borehole placement; as such, borehole locations are not described in this work plan. A geophysics data summary and interpretation memorandum will be prepared to identify borehole locations. The numerical groundwater model will undergo calibration and a sensitivity analysis to evaluate the suitability of the groundwater model for estimating groundwater movement through the CSA and ultimately for its utility in informing the risk assessment and formulation of remedial alternatives if needed. Calibration will be performed by manual and/or autocalibration (that is, parameter estimation software) methods and will focus primarily on transient groundwater elevation data (groundwater levels and vertical gradients) as calibration targets. Groundwater model construction and calibration will follow ASTM International guidance. Sensitivity analysis will be performed by varying key model parameters (horizontal and vertical hydraulic conductivity, recharge rates, and constituent transport parameters) within reasonable ranges to evaluate the influence of parameter uncertainty on model prediction of flow and transport forecasts and remedy effectiveness (if necessary).

#### **4.2.2 DQO 2: Role of the San Mateo Fault Zone in Groundwater Movement in the CSA**

DQO 2, presented in Table 4-2, is as follows: "Within the CSA, understand how the geologic structures within the San Mateo Fault Zone influence groundwater and constituent movement."

Goal: The study goal associated with DQO 2 is to develop information to refine the understanding of the location and hydraulic properties associated with the San Mateo Fault Zone within the CSA, specifically those that influence groundwater and constituent movement.

Information Inputs: Information will be obtained to satisfy this DQO using the following approaches:

- Surface geophysics (seismic reflection studies) across the San Mateo Fault Zone to identify faults within the bedrock units.
- ERT studies to evaluate faults within the depth of bedrock immediately below the saturated alluvial sediments and to characterize the contact with the alluvium where groundwater flow pathways may be affected by faults and offsetting bedrock units.
- Borehole geophysics to characterize the frequency and aperture of fractures present within the bedrock formations.
- Borehole lithologic logging to identify faults and presence of fault gouge; these data will assist in identification of structural features that may act as preferential groundwater flow paths or represent barriers to groundwater flow.
- Groundwater elevation data.
- Aquifer hydraulic tests
- Local geologic information from published sources including the U.S. Geological Survey, New Mexico Bureau of Geology and Mineral Resources, and industry-prepared technical reports.

Scope/Analytic Approach: Seismic reflection studies will be performed across the San Mateo Fault zone with geological structures interrogated within the bedrock system in the Upper CSA in the Crossroads Area (concurrent with ERT work here to evaluate alluvial and bedrock groundwater flow paths) as well as across the lateral axis of the alluvial channel in the Upper and Lower CSA. The seismic information will be coupled with, and in some cases correlated to, the ERT work throughout the shallower depths of the system. Of particular importance will be the development of cross section views through the depth of the alluvium and into bedrock and to investigate where faults in the bedrock might align with the base of the alluvial aquifer, as areas where groundwater movement may be affected by the faults. These cross sections will be used to guide placement of boreholes for further work to evaluate the fault zone. This will include characterization by downhole geophysics within the boreholes and lithologic logging to identify the presence of faults.

Acceptance Criteria and Plan: Similar to DQO 1, DQO 2 is focused on estimating physical properties of the rock within the CSA and will therefore rely upon professional judgment and subject matter experts to minimize estimation errors. The structural geology characterization plan will be part of the initial surface geophysics work, and the results will be documented in a technical memo that describes borehole locations and development/characterization.

#### **4.2.3 DQO 3: Background Geochemical Conditions and Water Quality within the CSA**

DQO 3, presented in Table 4-3, is as follows: "Characterize the background water quality conditions within the CSA alluvial sediments and bedrock aquifers."

Goal: The study goal associated with DQO 3 is to develop an understanding of the water quality within the alluvial and bedrock aquifers, including the concentration of constituents in groundwater that are associated with background conditions.

Information Inputs: Information will be obtained using the following approaches to satisfy this DQO:

- Borehole development and lithologic logging through the alluvial sediments (unsaturated and saturated zone materials) and into bedrock materials

- Saturated and unsaturated sediment sampling and geochemical (total elemental composition and leachable trace elements) and mineralogical analyses (petrographic analysis [light microscopy], X-ray diffraction, scanning electron microscopy, and energy dispersive spectroscopy)
- Samples collected from a range of sediment lithologies to assess the differences in COPC concentrations within a range of sediment types in the CSA
- Laboratory column tests using site groundwater and soil
- Determination of constituent concentrations and major ion and trace element concentrations of groundwater across the CSA
- Major cations and anions, including fluoride, total dissolved solids, arsenic, barium, boron, iron, manganese, uranium, selenium, nitrate, vanadium, radionuclides, and other solutes in groundwater
- Trace metals/elements in groundwater and soil
- Stable isotopes of oxygen, hydrogen, carbon, nitrogen, and sulfur in groundwater
- Dual stable isotopes of nitrogen-15/14 and oxygen-18/16 in nitrate and sulfur-34/32 and oxygen-18/16 in sulfate in groundwater
- Parent and daughter radionuclide isotopes, including radiogenic isotopes of radium and uranium, tritium, and carbon-14 in groundwater
- Total organic carbon and dissolved organic carbon
- Field parameters (pH, oxidation-reduction potential, dissolved oxygen, temperature, conductivity, turbidity)
- Uranium activity ratio analyses in groundwater
- Existing data developed by EPA and by HMC at the lower CSA boundary

Scope/Analytic Approach: The alluvial sediments and bedrock materials contain radionuclides and trace elements that are present due to natural conditions (the sediments are derived from ore-bearing weathered bedrock, and the bedrock hosts uranium ore deposits). These materials will be characterized for their elemental and mineralogical content and for the leachability of constituents to evaluate how the presence of naturally occurring minerals can lead to constituents being present in groundwater. Sediment samples will be obtained from various depths within the soil/sediment column, including above the historical high water level, and within the zone of groundwater level fluctuation and within the fully saturated zone. Multi-level sampling will provide information about soil chemical and mineralogical changes with depth; samples from above the historical high water level are best representative of natural conditions outside of the influence of groundwater inputs. Borehole geophysics will be used to guide sediment sample locations based on results of the downhole gamma scans (to target areas within the soil column with the highest gamma activity). Boreholes and groundwater wells will be located in areas where natural sources predominate. The results of sediment elemental and mineralogical composition and groundwater characterization at these locations will be compared to areas where other inputs are more likely. Geochemical characterization of soil samples will guide selection of specific samples for use in column tests to evaluate constituent leaching and attenuation under groundwater advective-flow conditions. Stable isotope analyses and uranium activity ratio analysis will also be used to locate background sediment and groundwater conditions; these analyses provide an indication of the source of sulfate: natural (sulfide or sulfate-mineral derived) versus other sources (sulfuric-acid derived) and uranium (by differentiating uranium present in groundwater due to natural weathering from mineral phases or due to chemical leaching). The groundwater monitoring will be performed at locations across the CSA over a 2-year period, with quarterly samples obtained. Seasonal fluctuations in groundwater quality and changes in geochemical conditions with time, and resultant water quality changes, will aid in determining background water quality conditions. Sediment chemical data and water quality data will be summarized and evaluated using statistical approaches including an evaluation of the parametric or non-parametric distribution of the data from multiple locations and over time and to calculate the 95 percent upper tolerance limit (UTL).

Acceptance Criteria and Plan: DQO 3 involves estimating the water quality/chemical characteristics of groundwater associated with background conditions (water quality unaffected by other current sources to the CSA). Data will be collected to estimate the mean chemical properties of the sediments, bedrock materials, and groundwater. Sediment properties will be estimated to relate these to groundwater quality and constituent concentrations. The relative standard error of the mean will be determined to assess the representativeness of the data collected, noting that groundwater constituent concentrations may vary based upon seasonality (recharge to groundwater) and changes in groundwater levels. Constituent concentrations associated with background conditions will be calculated based on the 95 percent UTL of the background data set at 95 percent coverage (UTL 95-95). Background water quality estimation will principally rely on identifying through geophysics and hydrogeological analyses the specific locations within the CSA with hydrogeological and geochemical conditions indicative of background; estimation of background water quality will also rely on identifying chemical fingerprints of background water quality from multiple locations across the CSA. The analytic approach described in DQO 4 (below), with respect to geochemical evaluation and modeling, will be used to develop these geochemical identifiers for background water quality. Details of the plan to characterize background water quality are provided in the FSP Section 4.2.

#### **4.2.4 DQO 4: COPC Distribution, Trends and Transport within CSA**

DQO 4, presented in Table 4-4, is as follows: "Characterize the distribution of COPC concentrations spatially and temporally, the hydrogeological and geochemical basis for this distribution, and transport properties of COPCs through the CSA."

Goal: The goal of DQO 4 is to characterize the current distribution of COPCs within the CSA and evaluate concentration changes with time (seasonally over 2 years of monitoring) and migration (travel time, transport properties) of COPCs in groundwater through the CSA.

Information Inputs: Information will be obtained to satisfy this DQO using the following approaches:

- Groundwater samples obtained from wells installed in saturated alluvial sediments and bedrock aquifers at key locations within the CSA to capture the spatial variability in COPC concentrations
- Groundwater samples obtained from existing wells within the CSA, with wells chosen based on the availability of information about well integrity and screened interval depths and lithologies
- Groundwater samples obtained over 2 years, with eight consecutive quarters of groundwater sampling to evaluate seasonal variability in COPC concentrations and trends over time
- Geochemical analysis of soils including mineralogy
- Geochemical analysis of groundwater as described for DQO 3
- Laboratory column tests using site groundwater and soil
- Geochemical and hydrogeological modeling of COPC groundwater transport characteristics in the saturated alluvial sediments and bedrock aquifers
- Compilation and review of all available data for locations within the CSA

Scope/Analytic Approach: Groundwater wells will be installed as part of the RI in locations identified to satisfy DQO 1 (characterize the hydrogeological properties of the CSA). These newly installed wells will be sampled over eight consecutive quarters for COPCs and other chemical constituents to characterize water quality within the CSA. Select existing wells will be sampled during this same period; these wells will be selected based on their location and after an evaluation of historical water quality trends. Any current wells selected for sampling will first be evaluated for knowledge of their construction details and confidence that completion depth and screened interval is correct. The well locations will primarily all be within the CSA; however, some locations may be required outside the CSA in order to sample bedrock units dipping to the northeast (e.g., the Dakota

Sandstone in the Crossroads Area). Groundwater data will be evaluated using geochemical and statistical approaches, including preparation of Piper and Stiff diagrams and statistical evaluation of the data sets to determine outliers, data distribution, and calculation of the 95 percent UTL at each location for each COPC. Bivariate plots, such as sulfate versus calcium, selenium, and uranium, and nitrate versus selenium, and uranium, and calcium versus uranium, will also be prepared.

Water level data for locations within the CSA will be compiled and reviewed. Geochemical analyses will include an evaluation of mineral stability and the mass transfer calculations to determine the amount of mineral dissolution and precipitation under equilibrium conditions; this will include (1) relevant geochemical reactions occurring between alluvial groundwater and reactive minerals (e.g., gypsum, calcite, smectite, kaolinite, amorphous silica, trace concentrations of fresh and oxidized pyrite, and ferrihydrite) present in the CSA, and (2) quantification of geochemical reactions and processes of importance that control groundwater composition, geochemical transient conditions of solutes, and fate and transport of COPCs.

Specific geochemical components of importance include aqueous speciation, acid-base reactions, oxidation-reduction, mineral precipitation/dissolution, and adsorption/desorption (surface complexation modeling). The geochemical modeling software PHREEQC (Parkhurst and Appelo, 2013) will help quantify the sources (dissolution) and the sinks (precipitation/sorption) of COPCs in the aquifer system. The analytical results for groundwater samples and mineralogical and geochemical characterization will serve as input to model simulations using PHREEQC. In addition, geochemical characterization of soil samples will guide the selection of specific samples for use in column tests to evaluate constituent leaching and attenuation under groundwater advective-flow conditions and to provide data to assist in the development of constituent transport parameters for use in the model (in addition to the use of geochemical modeling for parameter development).

Column tests will provide lower solid solution ratios (e.g., 0.3 to 1) to evaluate the partitioning of solutes in groundwater and soil as compared to the batch leach tests. The transport of COPCs within the CSA will be evaluated numerically through the implementation of a groundwater fate and transport model for the COPCs. Transport parameters for the COPCs, including retardation factors, will be developed and refined for the groundwater model and will be based on the geochemical evaluation and data analysis and column tests. A sensitivity analysis will be performed to evaluate how upper and lower ranges of retardation factors affect constituent transport rates and extent. More broadly, a sensitivity analysis will be performed on hydrological and geochemical input parameters to evaluate and identify those parameters for which constituent transport rate and extent is most sensitive to.

Acceptance Criteria and Plan: DQO 4 involves estimating the chemical characteristics of groundwater across the CSA and in particular COPC concentration distribution both spatially and temporally (over eight consecutive quarters). Data will be collected to estimate the chemical composition of groundwater and associated COPCs over eight consecutive quarters. There may be variability in these data due to seasonal fluctuations in constituent concentrations. This variability will be assessed in light of hydrogeological information obtained to satisfy DQO 1 (such as water level changes in response to seasonality). The plan for obtaining data to satisfy DQO 4 is detailed in the SAP and associated FSP.

#### **4.2.5 DQO 5: Risk Assessment**

DQO 5, presented in Table 4-5, is as follows: "Evaluate whether constituent concentrations in the alluvium or bedrock aquifers within the CSA pose an unacceptable risk to human or ecological health."

Goal: The study goal associated with DQO 5 is to evaluate the risk to human and ecological health associated with groundwater exposure within the boundary of the CSA.

Information Inputs: Information will be obtained to satisfy this DQO using the following approaches:

- Applicable risk assessment guidance (EPA, 2001; EPA, 1989; EPA, 1991; EPA 2019a)
- Groundwater concentrations of COPCs.
- The preliminary CSM report (Jacobs, 2021b) identifying human and ecological receptors.
- Site-specific screening levels for residential ranchers exposed to COPCs in groundwater via tap water use and the ingestion of homegrown produce and livestock. Screening levels will be calculated based on the EPA Regional Screening Level calculator (EPA, 2019b) and site-specific assumptions.
- Background concentrations of COPCs.
- Groundwater COPC migration pathways in the CSA.
- Potential human and ecological receptors for groundwater within the CSA.
- Details about groundwater-related removal actions performed by EPA and others within and around the CSA.

Scope/Analytic Approach: Groundwater data for COPCs will be obtained to satisfy DQO 3 and DQO 4. These data will be used to identify COPCs at concentrations greater than background in the CSA saturated alluvial sediments and bedrock aquifer units. Risk estimates for potential exposure to COPCs in groundwater will be estimated for each individual sample location to represent a potential individual's exposure at any given location within the CSA. Refined risk estimates will also be calculated considering natural background concentrations of COPCs and upper confidence limits (UCLs) on the mean concentrations. COPC concentrations will be compared to site-specific Regional Screening Levels to estimate risk using the risk ratio approach (EPA 1989; EPA, 1991). Uncertainties in sample collection, analysis, and the risk assessment process will be detailed.

Acceptance Criteria and Plan: Data identified as usable based on data validation will be included in the risk assessment. UCLs will be calculated using EPA ProUCL Software (EPA, 2015). The plan for the risk assessment is detailed in this work plan.

#### 4.2.6 DQO 6: Feasibility Study

DQO 6 is presented in Table 4-6 and is as follows: "Develop and evaluate an appropriate range of groundwater alternatives that ensure protection of human health and the environment."

Goal: The study goal associated with DQO 6 is to compile an appropriate range of remedial options for groundwater to assure protection of human health and the environment. An assessment of the human and ecological health risks will be completed to satisfy DQO 5.

Information Inputs/Boundaries/Analytic Approach. The RAOs, results of the HHRA and BERA, potential ARARs, and groundwater quality data (temporally and spatially) will be the key inputs for DQO 6. The water quality objectives will serve as the basis for treatment standards that may need to be met. The output from the hydrogeological model and constituent fate and transport model will identify the aerial extent of the aquifer that requires treatment and provide the mass flux of constituents through the CSA and at specific locations. These data will be evaluated and screened to compare alternatives against the seven criteria and then against each other. Innovative technologies will be included if applicable. Potential ARARs will be identified consistent with Title 40 *Code of Federal Regulations* Part 300.430(e)(2)(i).

Acceptance Criteria and Plan: Groundwater alternatives will be evaluated against the seven criteria provided in Title 40 *Code of Federal Regulations* Part 300.430(e)(9)(iii)(A) through (G). The remaining criteria, State Acceptance and Community Acceptance, will be evaluated following comment on the RI/FS report and the proposed plan in accordance with EPA CERCLA guidance. The plan for performing this evaluation is in the FS section of this work plan.

## 5. Remedial Investigation/Feasibility Study Tasks

### 5.1 Project Scoping

Scoping of the RI/FS process has two major aspects:

- Collect and assess existing data from previous investigations and other work performed at the CSA to identify COPCs, primary receptors, and exposure pathways. The following information was reviewed:
  - Current sources of groundwater COPCs, migration pathways, and potential human and environmental receptors
  - Physical, radiological, and chemical characteristics of the groundwater COPCs and distribution within the CSA
  - Previous sampling events conducted in the CSA
  - Previous responses conducted at the CSA by regulatory agencies
  - Geology, hydrogeology, hydrology, geochemistry, and meteorology of the CSA
  - Environmental characterization of the CSA
  - Background groundwater and sediment characteristics
  - Demographics and land use
  - Residential, municipal, agricultural and industrial wells at the CSA
  - Groundwater uses for areas surrounding the CSA

The outcome of this aspect of the scoping is the preliminary CSM report (Jacobs, 2021b) including determination of data gaps associated with the understanding of current conditions within the CSA

- Prepare project plans
  - The project plans are described in Section 1 of this work plan.

This work plan is prepared based on the outcome of the review of available information for the CSA with the specific goal for the plan to address data gaps such that the risk assessment and FS portion of the project can be completed. The preliminary CSM report summarizes the review of available information and identifies data gaps relative to the understanding of current groundwater conditions within the CSA and risk to receptors. Additional work will be done to further assess available data and interpretations prior to use in the RI as the field activities progress.

#### 5.1.1 Data Gaps Evaluation

During project scoping and review of available information, a preliminary CSM was developed to provide an overview of the current groundwater conditions within the CSA. The preliminary CSM report was also used to develop an understanding of data gaps; the CSM will be used to guide field investigations (for the geophysics investigation, locating boreholes and monitoring wells, geochemical investigations, and sample collected and analysis). The CSM will be updated as new data are collected as part of the RI phase of the project, and it will also be used to inform laboratory studies (e.g., column experiments).

Groundwater movement in the CSA, and hence COPC distribution, is dictated by physical conditions (hydrogeological properties of the saturated alluvial sediments and alluvial aquifer within the CSA, as well as the bedrock units) and geological properties (structural geology including faults and contacts between different

geological units and water-bearing members [hydrostratigraphic units or HSUs]). Chemical conditions also play a major role in the presence and distribution of COPCs, including geochemistry of the groundwater and saturated soils, along with the mineralogy of the soils. Data gaps related to the geochemical conditions within the CSA were identified; these include developing an understanding of the distribution of major ions and trace elements through the CSA and transient geochemical conditions that may influence this distribution, such as seasonal controls on concentrations and hydrogeological and geological controls (e.g., water levels, tributary drainages, and faults). Current influxes of groundwater into the CSA may also have a significant influence on water quality and COPC distribution. The outcome of the data gaps evaluation includes data needs associated with the physical and chemical properties of the CSA, all of which are required to assemble a refined and accurate understanding of current groundwater conditions such that a risk assessment and FS can be performed to inform appropriate strategies for the CSA.

### **5.1.2 Hydrogeological Data Needs (Informs DQO 1)**

The data gaps evaluation identified the following hydrogeological data needs associated with the characterization of current groundwater conditions and improved understanding of the water balance within the CSA:

- Inventory of existing monitoring and private well locations; survey to common/known horizontal and vertical datum
- Three-dimensional characteristics of the alluvial aquifer system
- Movement of groundwater (gradients/flow directions) in the bedrock HSU
- Vertical hydraulic gradients between HSUs
- Hydraulic characteristics of faults and other structural features
- All available water level data for locations within the CSA
- Hydraulic properties of HSUs (alluvium and bedrock units) and lateral and vertical variability
- Magnitude and distribution of current pumping (private and industrial) and HSUs, locations, and volumes
- Current stream gauge measurements along San Mateo Creek and (if necessary) and Arroyo del Puerto
- The extent of saturation of bedrock formations in direct contact with the alluvium, particularly in targeted formations in the Upper CSA (Dakota Sandstone, Westwater Canyon [Morrison Formation], and Tres Hermanos Sandstone of the Mancos Shale)

### **5.1.3 San Mateo Fault Zone Data Needs (Informs DQO 2)**

The data gaps evaluation identified the following geological data needs associated with the characterization of current groundwater conditions within the CSA:

- The role of the San Mateo Fault within the bedrock units of the CSA and its effect on the path that groundwater follows through the CSA.
- Hydraulic properties of the San Mateo Fault Zone and their influence on the potential downward migration of alluvial groundwater along the fault zone.
- Strata correlation across faults in the CSA and how the strata are hydraulically connected across faults; particularly how geologic structures along the San Mateo Fault Zone influence hydraulic properties of water-bearing members, groundwater flow, and constituent mass flux.

- The base of alluvium structure and the extent of saturation within the Lower CSA; particularly the alluvial thickness, saturated alluvial thickness, base of alluvium, and alluvium-bedrock contact perpendicular to long-axes of the San Mateo Creek channel and tributary drainages across the San Mateo Fault Zone.
- Physical properties of alluvium and bedrock in the CSA. Except where measured in geophysical borehole logs and along surface geophysical transects previously completed in monitoring wells and adjacent to the CSA, physical properties of alluvium and bedrock are generalized according to their lithology type and as such their influence on HSUs is only partially defined. The influence of fractures in bedrock and alluvial heterogeneity, and the influence each may have on the nature and volume of incoming groundwater flow from the upgradient San Mateo Creek alluvium, the Arroyo del Puerto alluvium, the unnamed tributary alluvium north/northeast of the Crossroads Area, and the Poison Canyon alluvium are only partially defined.

#### **5.1.4 Data Needs Associated with Water Quality, COPCs, and Potential Receptors (Informs DQOs 3, 4, and 5)**

The data gaps evaluation identified the following water quality, COPC, and potential receptor data needs associated with the understanding of current groundwater conditions within the CSA:

- The current status of the mines within the CSA is unknown with respect to the potential risk to groundwater, and human and ecological health.
- Background water quality conditions within the CSA.
- The basis for the relationships between constituent concentrations (both spatially and temporally) within the CSA is currently poorly understood.
- Detailed mineralogical evaluation of the alluvial sediments is limited to the southern portion of the Lower CSA (this includes sorption parameters for COPC sorption to sediments); mineralogical characteristics of the alluvial sediments across the CSA and their variability and the contribution of sediment mineralogy to water quality within the CSA is a data gap.
- Mineralogical composition of the bedrock units that exist within the CSA is better established than for the alluvium; however, there is not a current understanding of how mineralogy in the bedrock aquifer units affects groundwater quality.
- COPC transport velocities through the CSA are estimated here; however, this requires refinement through the use of a numerical groundwater fate and transport model.

The RI and activities described below are associated with filling data gaps and satisfying data needs to complete the risk assessment and FS (with the FS focused on satisfying DQO 6).

## **5.2 Remedial Investigation Approach - Overview**

### **5.2.1 Sampling Rationale**

This section describes the overall rationale for the work elements proposed as part of the RI field program. This general discussion is intended to convey the specific objectives of each field program component. Proposed details, such as construction details of individual wells, specific sample types, collection strategies, and other associated details are in the FSP Section 4.

### **5.2.2 Surface Geophysics**

The proposed surface geophysical program will employ two technologies: ERT and seismic reflection profiles. Data collected using these subsurface investigation techniques will be used to achieve three objectives of the field program:

- Estimate the three-dimensional extent of the saturated alluvial materials
- Identify locations and structures associated with the San Mateo Fault Zone
- Improve characterization of the bedrock stratigraphy within the CSA

Obtaining an accurate depiction of the three-dimensional extent of saturated alluvium is a critical element of the CSM because it defines the limits of the subsurface system responsible for groundwater flow, and any constituents dissolved within, through the CSA above the underlying bedrock.

The location and properties of the San Mateo Fault Zone are also key components of the CSM because they may represent a preferential pathway for groundwater and COPCs to travel through otherwise less permeable bedrock. However, the presence of fault zones does not necessarily prove the presence of a preferential pathway for flow because some fault systems are associated with the presence of significant damage zones and/or fault gouge that can actually represent low permeability barriers to flow. The information obtained from the surface geophysical field investigation, used in conjunction with other planned data collection activities (such as packer testing), will be critical in evaluating the hydraulic properties of the San Mateo Fault Zone and how these properties may vary with location along the fault. Finally, the surface geophysical investigation program will provide additional information regarding the stratigraphy and properties of the bedrock formations at depth within the CSA. These data are necessary to improve understanding of the role that the bedrock units may play in deeper groundwater movement at the site.

### **5.2.3 Alluvial Borings/Well Installations**

The installation of alluvial borings and monitoring wells will provide key information for the detailed variability in lithology of the alluvial materials within the CSA. Current available data suggest that the alluvial deposits in the San Mateo Creek drainage are heterogeneous, with highly variable proportions of gravel, sand, silt, and clay at different locations within the alluvial deposits. Generally, the coarser-grained, higher-permeability material is found at depth within the main San Mateo Creek drainage channels, with finer-grained deposits observed at the lateral edges of the alluvial deposits. Very coarse-grained gravel deposits, known as paleochannels, have been observed at depth within the alluvial system. Identification of these features would be an important component of the CSM because they represent preferred groundwater pathways that may result in groundwater flow velocities and flow rates, and potentially constituent fluxes, that are significantly higher than would be expected from more typical alluvium present in the area. The alluvial borings will also play a key role in the ground-truthing of geophysical data collected along the planned transects. Alluvial borings will be located along the planned transects to provide physical samples of the subsurface materials present, to compare with the geophysical data collected and to correlate the geophysical signals with a specific lithology. Groundwater elevation data collected from these wells will also provide key information to the CSM as is discussed below.

### **5.2.4 Bedrock Borings/Well Installations**

Similar to the alluvial borings and well installations, the installation of bedrock borings and wells will provide key information on the detailed lithology and structure of the geologic units at the site, however, in this case focusing on the bedrock formations underlying the alluvium. Information obtained during drilling and coring will allow identification of geologic formations penetrated and provide additional information on the stratigraphic relationships between these formations. Bedrock borings targeting the San Mateo Fault Zone will provide direct observation of the nature and composition of the materials associated with the fault zone such as fault gouge and damage zones. These observations, along with associated hydraulic testing, will provide key data with which to evaluate whether the San Mateo Fault Zone represents a permeable preferential pathway through the bedrock for groundwater and COPC migration. Information obtained from the bedrock coreholes will also allow for ground-truthing and calibration of the geophysical signatures obtained from surface geophysical profiles with physical rock properties.

### 5.2.5 Downhole Geophysics/Corehole Dynamic Flow Meter/Depth Discrete Groundwater Sampling

The installation of coreholes into the bedrock formations will allow collection of a wide range of data that will inform the CSM regarding the physical and hydraulic properties of the bedrock flow system and how these characteristics vary spatially across the CSA. After completion of each bedrock corehole, a suite of geophysical instruments will be deployed within the borehole to collect key information such as the following:

- Caliper log: Physical configuration of corehole walls
- Natural gamma/resistivity/electromagnetic logs: Identify particular lithologies by detecting natural signatures
- Fluid temperature/conductivity: Identifies trends with depth that may reflect flow from particular fractures
- Corehole dynamic flow meter: Measures groundwater inflow and outflow zones under ambient and pumping conditions
- Fracture aperture/orientation data: Measure three-dimensional orientation and fracture aperture width for each fracture encountered
- Optical and acoustic televiewer logs: Provide video and acoustic images of corehole wall including fractures and staining

Data obtained from these various geophysical techniques provide a wealth of information regarding the physical, lithologic, and fluid migration within the borehole. These data are critical to understanding how a fault zone, or bedrock formation may transmit both groundwater and COPCs through the subsurface. Two other data collection efforts associated with this data element are packer testing and depth discrete groundwater sampling. Both of these efforts consist of installing inflatable packers at various depths in the borehole to hydraulically isolate fractured intervals. A groundwater sample is collected from each sample interval followed by performing a packer test in the same interval. The packer test results provide a direct measure of the hydraulic conductivity of each fractured interval, while the groundwater sample informs the quality of groundwater moving through that fracture set. In combination, these two data sets allow for computing the mass flux of COPCs moving through various depth intervals within the bedrock aquifer system.

### 5.2.6 Aquifer Testing/Packer Testing

Aquifer testing and packer testing are included in the RI field effort to provide estimates of hydraulic conductivity for both the alluvial sediments and the bedrock aquifer. Traditional aquifer testing will be performed in four alluvium wells and four bedrock wells. These data will be critical to understanding the groundwater velocities with the flow rates moving through the site, as well as the spatial variability across the CSA. Packer testing provides similar information for the fractured bedrock system as is discussed above.

### 5.2.7 Water Level Gauging

Groundwater elevation data are fundamental elements of any CSM. Synoptic groundwater elevations will be collected quarterly from all new monitoring wells associated with the groundwater quality sampling efforts. Groundwater level gauging will also be conducted in select existing monitoring wells within the CSA where well construction information is available. It will be necessary to collect survey data for these wells because accurate well head elevations are generally not available. Accurate groundwater elevations support a wide range of hydrogeologic evaluations including computation of groundwater gradients and flow velocities, general groundwater flow pathway interpretations, and vertical hydraulic gradients between the alluvium and bedrock aquifers to evaluate the potential for vertical exchange of groundwater between the alluvium and bedrock.

### **5.2.8 Water Quality Sampling**

The final element of the RI field work is groundwater quality sampling. Groundwater sampling for site COPCs will be performed for eight quarters from all newly installed monitoring wells and a subset of existing monitoring wells in key locations. The EPA, in consultation with the Working Group and NMED, will select the final subset of existing monitoring wells for sampling. These data will be used to refine the understanding of the spatial distribution of COPCs within the alluvium and the bedrock aquifer system.

## **5.3 Field Investigation**

RI field investigation activities include site access, surface and borehole geophysical surveys, soil, and groundwater (alluvial and bedrock) sampling and analysis, aquifer testing, and geodetic surveying within the CSA as well as investigation-derived waste management. A detailed sampling approach, including sample collection methodologies, procedures, field documentation, and decontamination methods, is presented in the FSP Sections 4 through 8. Analytical DQOs, data management procedures, and field measurement criteria are presented in the QAPP.

The schedule discussed in Section 6 summarizes the progressive and sequenced investigation described below.

### **5.3.1 Site Access and Cultural Awareness and Protection**

Prior to performing field work, access agreements must be obtained between the Working Group and landowners where the field investigation is to be performed. Property where the field work is to be performed has been identified as privately and publicly owned land. The State of New Mexico and the U.S. Bureau of Land Management are the publicly owned landowners. Securing access agreements to these properties will involve addressing items of potential cultural significance through the process of a cultural resource investigation. The cultural resource investigation will comply with Section 106 of the National Historic Preservation Act of 1966. A Cultural Awareness and Protection Plan has been prepared and is included as Appendix A. The Cultural Awareness and Protection Plan addresses the process that will be implemented. A qualified specialty subcontractor with experience completing cultural resource investigations and engaging in coordination with federal regulatory, federal and state historic preservation, and tribal agencies (as appropriate) will be used.

### **5.3.2 Phase 1 Surface Geophysical Surveys and Preliminary Subsurface Interpretations**

Data and information obtained during the Phase 1 RI activities will be used to enhance the CSM, in particular the subsurface geology, hydrology, and hydrogeology-related aspects of the CSM.

Phase 1 RI field activities include:

Collecting ERT survey data along five transects along the San Mateo Creek channel and tributary drainages across the San Mateo Fault Zone to determine the base of alluvium structure, estimate the extent of alluvial saturation, evaluate faults within the depth of bedrock immediately below the saturated alluvial sediments, and characterize the contact with the alluvium where groundwater flow pathways may be affected by faults and offsetting bedrock units. These include:

- Upgradient San Mateo Creek alluvium perpendicular to long axes of the San Mateo Creek channel
- Alluvium perpendicular to tributary drainages across the San Mateo Fault Zone
- Arroyo del Puerto alluvium
- The unnamed tributary alluvium north/northeast of the Crossroads Area
- Poison Canyon alluvium

ERT interpretations will include estimates of alluvial thickness, saturated alluvial thickness, base of alluvium, and alluvium-bedrock contact. These interpretations will be used to estimate the nature and volume of incoming groundwater flow from the upgradient San Mateo Creek alluvium, Arroyo del Puerto alluvium, unnamed tributary alluvium north/northeast of the crossroads, and Poison Canyon alluvium.

- Collecting seismic reflection survey data along four transects to understand the nature of the faulting along the San Mateo Fault Zone and also to evaluate the potential for downward migration of the groundwater COPCs along the San Mateo Fault Zone. Seismic reflection interpretations will be used to correlate strata across faults in the CSA, supporting identification of strata potentially hydraulically connected across faults, and to identify if and how geologic structures along the San Mateo Fault Zone may influence hydraulic properties of water-bearing members, groundwater flow, and constituent mass flux.

### **5.3.3 Phase 1 Surface Geophysical Subsurface Surveys Interpretation Memorandum**

Following completion of Phase 1, subsurface interpretations based on surface geophysical surveys, data analysis, and interpretation will be summarized in a memorandum. Surface geophysical transect surveys and preliminary subsurface interpretations will be used to optimize locations of proposed alluvial and bedrock borings, monitoring wells, aquifer tests, and analytical samples. Subsurface interpretations will identify interpreted alluvium-bedrock contacts, structures, and faults. The memorandum will be submitted for EPA and NMED review and approval.

The Phase 1 memorandum will include figures proposing final locations of alluvial and bedrock boring and well locations. Alluvial borings and wells will be proposed at locations where preliminary interpretations identify cross-sections with channel-shaped geometry, resistivity values indicating sediment heterogeneity potentially corresponding to permeability or mineralogical characteristics indicative of preferential pathways for constituent transport. In addition, alluvial borings and wells will be located in key areas near the San Mateo Fault Zone to collect groundwater elevation data, specifically as an information input for DQO-2 (Role of the San Mateo Fault Zone in Groundwater Movement in the CSA). Borings will also be located in areas determined to be appropriate for monitoring natural background water quality.

Near to each ERT profile in the Lower Study Area alluvial wells will optimally be located to sample wells screened within coarse-grained sediment and wells screened within fine-grained sediment to provide data to further refine and update the CSM for constituent transport.

Bedrock borings and wells will be proposed at locations where interpretations of Phase 1 geophysical surveys identify features indicative of saturation of bedrock formations in direct contact with alluvium, where structures or faults indicate potential for vertical migration of COPCs, where faults in the bedrock might align with the base of the alluvial aquifer, and areas where groundwater movement may be affected by the faults.

The FSP identifies analytical sampling procedures, locations, frequency, and rationale.

### **5.3.4 Phase 2 Borehole Development, Soil Sampling, Borehole Geophysical Logging Surveys, and Monitoring Well Installation and Hydraulic Evaluation**

Analytical data collected for soil during borehole development will provide information on background concentrations and leachability of constituents, refine geological interpretations, and confirm geophysical data collected during the Phase 1 RI activities. Analytical data collected during the groundwater investigation will provide information on specific aquifer characteristics that will be used to refine the groundwater numerical flow model, evaluate concentrations of COPCs within the CSA, and assess seasonal variability of COPCs and groundwater quality parameters within the alluvial and bedrock aquifers.

Phase 2 RI field activities include installing an appropriate number of alluvial and bedrock boreholes at locations defined during the Phase 1 RI activities, with the number of boreholes determined based on satisfying the DQOs. Soil borings will be installed using the rotary sonic drilling technique and will include continuous core retrieval. Alluvial boreholes will be advanced to depths adequate to penetrate a minimum of 5 feet of underlying bedrock. Soil and bedrock core will be lithologically logged, and analytical samples will be collected at depths determined by the field geologist. Analytical samples will be collected at the following targeted locations within each borehole:

- Above the historical high-water table. This depth will be determined from historical site data.
- Within the aquifer smear zone where the water table has risen and fallen through time.
- Within the saturated sediment.
- Within the water-bearing zones of the targeted bedrock formations, the emphasis will be on the Dakota Sandstone and the Westwater Canyon Member of the Morrison Formation.

Completing Borehole Geophysical Logging Surveys in an appropriate number of borings to refine interpretations of the geologic, hydrogeologic, and geochemical conditions within the alluvium and bedrock within the CSA. The selected number of borings will be determined after evaluation of the surface geophysics data and based on the need to verify specific hydrogeological features associated with these results.

Borehole geophysical logging surveys will be completed as follows:

- In selected alluvial borings throughout the CSA, to provide quantitative, in-situ measurements to link interpretations between visual geologic descriptions, logged lithology, and surface geophysical survey interpretations.
- In selected alluvial borings nearby to ERT profiles, to calibrate and constrain ERT inversions and models, optimizing subsurface geologic interpretations.
- In selected alluvial borings nearby to ERT profiles, to provide a direct measure of resistivity conditions and estimate uncertainty ERT models vertical resolution, and estimate hydraulic properties including saturation, porosity, and sediment heterogeneity.
- In selected alluvial borings to refine lithologic and stratigraphic interpretations in specific locations to refine interpretations of depositional environments within the alluvium.
- In selected alluvial borings to estimate in-situ concentrations of potassium (K), uranium (U), and thorium (Th) within the alluvium in order to identify relationships between naturally occurring uranium and stratigraphic, mineralogy, geochemical parameters, and alluvial sediments provenance in the CSA.
- In selected bedrock borings nearby to seismic reflection profiles, to refine structures and faults initially interpreted from seismic reflection interpretations.
- In selected bedrock borings, to characterize fractures and site corehole dynamic flow meter tests.
- In selected bedrock borings nearby to seismic reflection profiles to collect formation velocity characteristics to calibrate and constrain seismic reflection interpretations through time-to-depth conversions.

In addition to the targeted soil sampling locations listed above, samples will be collected from a range of sediment lithologies to assess the differences in COPC concentrations within a range of sediment types in the CSA. Analytical methods, bottleware, holding times, and analytical laboratory details are provided in the project-specific QAPP (Jacobs, 2021a).

Groundwater monitoring wells will be installed in a subset of soil borings and at depths determined by field observations in conjunction with data collected during the Phase 1 RI activities. Monitoring wells will be

composed of 4-inch inner-diameter polyvinyl chloride and will be installed per requirements in the New Mexico Office of the State Engineer permits, which will be obtained prior to well installation. Monitoring well details, including estimated screen lengths, slot size and type, and annular material are in the FSP.

Prior to installation of monitoring wells in bedrock boreholes, hydraulic packer aquifer tests will be completed within the open bedrock borehole at each location. Hydraulic packer tests will be conducted on specific bedrock fractures, identified during geophysical borehole logging, to obtain data necessary to evaluate aquifer matrix and groundwater flow characteristics in specific fractures.

Data collected from constant-rate extraction aquifer tests will be used to evaluate the hydraulic properties of the alluvial and bedrock units, and the degree of hydraulic connection between lithologic units within the CSA. Aquifer extraction tests will be conducted within a subset of newly installed monitoring wells and will consist of:

- 8-hour step rate extraction tests, conducted to establish extraction rates for subsequent constant-rate extraction tests
- 72-hour constant-state extraction tests
- 7-day aquifer recovery monitoring

Investigation-derived waste (soil and bedrock cuttings, purge, and decontamination water) generated during groundwater investigation activities will be sampled, containerized, transported, and disposed of as described in Section 4.6 of the FSP.

### **5.3.5 Phase 3 Quarterly Groundwater Monitoring**

Monitoring wells installed during the Phase 2 RI activities will be sampled quarterly, for eight consecutive quarters, to determine COPC concentrations and assess seasonal variations in concentrations within the CSA. Existing monitoring wells within the CSA, located in areas where data will be important to obtain to complete the evaluation of COPC nature and extent, will also be sampled with the list of wells identified by EPA in consultation with the Working Group and NMED. The existing wells will first be evaluated for their suitability for sampling based on construction logs (to determine whether information is provided for the geologic unit within which the well is completed, along with screened interval depth) and an assessment of well conditions. These wells will also be sampled for eight quarters. Key analytes and COPCs will be sampled each quarter; whereas, other analytes will be sampled less frequently. The analyte list and sampling frequency details are in Section 4 of the FSP.

Groundwater samples will be collected with decontaminated submersible pumps and dedicated tubing installed in each monitoring well. Groundwater quality parameters will be collected during purging, and samples will be collected when parameters have stabilized, as described in the EPA low-flow sampling guidance (EPA, 1996). The analyte list, bottleware, holding times, and analytical laboratory details are in the QAPP.

Purge and decontamination water generated during groundwater sampling activities will be containerized, transported, and disposed of as described in Section 4.6 of the FSP.

### **5.3.6 Preliminary Study Area Characterization Report**

At the conclusion of the eight quarters of groundwater monitoring, the preliminary study area characterization report will be prepared to summarize the groundwater data. This report will summarize the field activities associated with Phases 1, 2, and 3 of the RI, including surface and downhole geophysics, hydrogeological characterization of the alluvial and bedrock system, and geochemical and mineralogical evaluation of the sediments and bedrock materials obtained from the boreholes. The report will also include the groundwater numerical model as well as the constituent fate and transport evaluation; this model will provide a more quantitative assessment of groundwater and constituent movement within the CSA, and model construction will

use the data obtained during the RI. Groundwater model construction is discussed in the preliminary CSM report (Jacobs, 2021b).

The findings of the field investigation work will be presented at a meeting with EPA, NMED, and MMD prior to submittal of the report to the agencies for review. The report, and data therein that describes the current conditions within the CSA to satisfy DQOs 1 through 4, will serve as the basis for the baseline risk assessment, and development and screening of the remedial alternatives, RAOs, and identification of ARARs.

#### **5.3.7 Refinement of Preliminary RAOs**

The refined list of preliminary RAOs will be provided to EPA when the Preliminary Study Area Characterization Report is submitted.

#### **5.3.8 Preliminary RAAs and ARARs**

The preliminary RAAs and associated technologies, and ARARs, will be provided to EPA when the Preliminary Study Area Characterization Report is submitted.

### **5.4 Sample Analysis/Validation**

Sample analysis will follow the analytical method requirements outlined in Section 4.4 of the QAPP. Data validation will follow the process described in Section 6 of the QAPP.

### **5.5 Data Evaluation**

Following data validation, data quality reports will be developed as outlined in Section 8 of the QAPP. Usability of the data for project decision making will be evaluated by the team against the DQOs as described in Section 4.2.

#### **5.5.1 Data Management Plan**

The data workflow process is described in detail in the Data Management Plan, included as Appendix B to this work plan.

### **5.6 Assessment of Risks**

The HHRA will be conducted in accordance with applicable EPA guidance, including but not limited to the following:

- Interim Final Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part A) (EPA, 1989)
- Interim Final Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part D) (EPA, 2001)
- Additional applicable guidance as listed in the RI/FS SOW (EPA, 2019a) or subsequently issued guidance

The HHRA will include exposure scenarios representative of current and potential future land use including resident ranchers exposed to groundwater within the CSA via household use (such as ingestion and dermal and inhalation exposure) and consumption of homegrown produce and locally grazed livestock (Jacobs, 2021b).

A BERA problem formulation report will be developed to evaluate potential ecological exposure to groundwater in the CSA. Based on the CSM (Jacobs, 2021b), the report will be brief because no ecological receptors of groundwater within the CSA have been identified; therefore, a BERA is likely not necessary.

Primary COPCs identified include selenium, uranium, and radium-226 and -228. The COPC concentrations will be evaluated in the risk assessments and compared to background concentrations and well as risk-based screening levels (RBSLs) (for example, EPA Regional Screening Levels [EPA, 2019b] or current) for chemicals and PRGs ([EPA, no date] for radionuclides) to evaluate whether they are COCs requiring risk management.

#### **5.6.1 Baseline Human Health Risk Assessment**

Human exposures to groundwater will be evaluated on a point-by-point basis to evaluate a potential exposure at any given location; likely a conservative approach, this reasonable maximum exposure estimate assumes that a residential or irrigation well may be drilled at any one, specific location. Site-specific RBSLs will be calculated using current toxicity criteria and default and site-specific (where applicable) exposure parameters associated with the CSM, which will assume land uses including consumption of homegrown produce and locally grazed livestock. Risk estimates will then be calculated using the maximum concentration of each COPC, the associated RBSL, and the risk ratio or sum of fractions approach (EPA, 1989; EPA, 1991). In the sum-of-fractions approach, human health cancer risk and non-cancer hazard estimates are quantified as the ratio of a chemical-specific exposure point concentration to corresponding RBSLs and then summed to a cumulative cancer risk or non-cancer hazard index, as appropriate. Central tendency exposures will be evaluated to address potential uncertainties in using reasonable maximum exposure assumptions for risk management decisions by evaluating risks based on UCL-based exposure point concentrations (for localized wells/samples and individual aquifer) for groundwater, consideration of frequency of detection or exceedance, background concentration comparisons, or an evaluation of the site-specific bioaccessibility/bioaccumulation of COPCs in livestock. Chemicals for which toxicological data are not available will also be addressed as uncertainties in the HHRA.

#### **5.6.2 Ecological Risk Assessment**

The preliminary CSM indicates that groundwater is not in hydraulic communication with adjacent surface water features. Transport mechanisms to environmental media and subsequent exposure pathways to ecological receptors are therefore not complete. As described, a BERA problem formulation report will be prepared that describes potential exposure pathways for ecological risk; however, it is likely these are not complete and a BERA will likely not be performed. The preliminary CSM report assumes that there is no input of groundwater to surface water; therefore, the exposure to ecological receptors is considered to be incomplete. If groundwater is found to enter surface water during the RI, the incomplete exposure pathway to ecological receptors would need to be reconsidered and, if determined necessary by EPA, the other steps in performing the ERA, following the problem formulation, would need to be completed as stated in the SOW. The scope of ERA activities (following completion of the BERA problem formulation report) will be refined later in the RI process if an exposure pathway from groundwater to surface water is identified. These additional ERA activities will be provided to EPA through a work plan revision/addendum.

### **5.7 Treatability Study/Pilot Testing**

An evaluation of potential groundwater treatment technologies based on CSA alluvial groundwater data and on possible type of use is presented in the Identification of Candidate Technologies for Treatability Studies Technical Memorandum (Jacobs, 2021c). Based on the state-of-the-art of the candidate technologies, information available from vendors, level of experience either within the CSA or at the HMC Mill site, Jacobs in-house experience, and the expected ability to collect the necessary site information during the RI, it was concluded that treatability studies are not likely to be needed to support the FS. If EPA determines that treatability studies are required, the work described in the sections below will be performed.

### **5.7.1 Literature Survey**

The first step would comprise understanding the level of need and scope for treatability studies to satisfy data or information gaps that exist and what further information may be needed to develop and evaluate alternatives. Information gaps that cannot be filled using existing information will be identified during a review of the available site information and literature on technologies to determine whether the available data are sufficient to develop and evaluate alternatives. This activity will be facilitated by performing a study of the literature to gather information on performance, relative cost, applicability, removal efficiencies, operation and maintenance requirements, and implementability of candidate technologies.

Information gaps will be identified and presented within a Literature Survey Technical Memorandum, as detailed in the AOC.

If existing information is not sufficient to fully develop treatment alternatives and further study is needed to develop and understand the effectiveness, particular design parameters, and potential cost of technologies for FS alternatives, then treatability studies may be required. If treatability studies are deemed necessary, a detailed treatability study work plan will be developed with an updated SAP defining the sampling activities to be performed during the treatability study.

### **5.7.2 Treatability Studies Work Plan**

The treatability study work plan would include the following:

- A description of the data to be gathered to conduct treatability studies of candidate technologies
- A description of the type of treatability test required to test each candidate technology
- A description of the CSA background, candidate remedial technologies to be tested, test objectives, experimental procedures, treatability conditions to be tested, measurements of performance, analytical methods, data management and analysis, health and safety, residual waste management, and documentation of the DQOs for treatability study testing
- A description of permitting requirements and how they will be met and a project schedule for completion
- If necessary, an updated health and safety plan to be submitted for review

### **5.7.3 Perform Treatability Studies**

Bench- or pilot-scale treatability studies would then be performed in accordance with the approved treatability study work plan and schedule. Results would be evaluated in consultation with EPA for application of the technology at full-scale to determine whether limitations of bench- or pilot-scale tests exist and whether they need to be considered prior to or during full-scale implementation.

### **5.7.4 Treatability Studies Report**

Following treatability studies, a treatability studies evaluation report would be submitted to EPA. This report would evaluate the technologies' effectiveness and implementability in relation to established PRGs for the CSA. In this report, actual results would be compared with predicted results to justify the effectiveness and implementability discussions.

## **5.8 Remedial Investigation Report**

At the completion of RI activities described in this work plan, an RI report will be prepared using the newly collected data and existing data (after review of this data for its quality and suitability for use in the RI). The

report will be prepared in accordance with the outline presented in the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988). The report will directly address the identified data gaps and summarize the characterization data collected during the RI activities including, but not limited to, surficial and borehole geophysical data, aquifer testing results from packer testing and pumping tests, soil and groundwater sampling field and analytical data, and soil boring logs and monitoring well completion diagrams. The RI report will include the following:

- Description of field investigation and methods used
- Results of field investigation including background groundwater conditions
- Detail of current sources; nature and extent and fate and transport of COCs within the CSA; and an updated CSM (with the results of the numerical groundwater fate and transport model incorporated into the updated CSM)
- Results of the baseline risk assessment
- Preliminary chemical- and location-specific ARARs and PRGs
- Recommended RAOs
- Conclusions and recommendations such as the need for groundwater response actions

## **5.9 Remedial Alternatives Development and Screening**

The objective of remedial alternative development and screening is to compile an appropriate range of remedial options that assure protection of human health and the environment for evaluation in the detailed analysis of alternatives section of the FS. The range could include options in which treatment is used, options involving containment with little or no treatment, options involving both treatment and containment, use of institutional controls, and a no action alternative. An option for using point-of-use treatment at residential taps or wellheads or municipal supply drinking systems will also be considered.

### **5.9.1 Initial Steps**

The first step in this process will be to hold the initial feasibility meeting in which the plans for the FS are discussed and objectives aligned with EPA, NMED, and the Mining and Minerals Division of the New Mexico Energy, Minerals, and Natural Resources Department. The developed PRGs, risk calculations, initial steps for remedial alternatives, and the preliminary RAOs will be reviewed during this meeting. The preliminary RAOs will be refined based on discussion from the initial feasibility meeting, the CSA characterization, results of the HHRA, and the list of potential chemical-specific ARARs prior to submittal of the RAO technical memorandum to EPA for review and approval.

General response actions defining containment, treatment, pumping or other actions, singly or in combination, will then be developed to satisfy the RAOs. A draft summary of the general response actions may be submitted as an optional submittal, which will be discussed at the initial feasibility meeting or during an interim FS meeting.

### **5.9.2 Identification of Extent of COCs**

The volume of aquifer material (alluvium and bedrock) containing elevated COCs in groundwater will be estimated to characterize the extent, assess the risk of elevated COCs to potential groundwater receptors, and help identify the optimal remedial technologies that could be implemented. Groundwater quality data from new and existing monitoring wells will be used to estimate the spatial extent of COCs within the alluvial and bedrock aquifers. COC concentrations obtained from well sampling in conjunction with spatial analysis tools, such as Earth Volumetric Studio, will be used to develop estimates of three-dimensional distribution considering not only the COC data but also the geological/lithological influences of COC migration. Temporal trends in COC data sets will

be evaluated to improve the understanding of how the COC distribution is changing over time and how factors such as degradation, adsorption, and dispersion will influence COC levels and extents into the future.

### **5.9.3 Generate and Refine Remedial Technologies and Process Options**

Technologies and process options applicable to each general response action, such as containment, collection, pumping, treatment, discharge, and treatment residuals management will be identified and evaluated. Technology types and process options identified will include a no-action option, institutional controls, source control actions, groundwater response actions, both in situ and ex situ process options, and innovative process options as reasonably applicable to the CSA specifics. These alternatives will be screened singly or in combination on the basis of effectiveness, implementability, and cost. One or more representative processes for each technology type will be retained during screening, and the reason for eliminating technologies and options will be clearly summarized.

### **5.9.4 Assemble and Document Remedial Alternatives**

Retained representative technologies and options will be assembled into alternatives for site groundwater, including a no action alternative. This will include a limited number of alternatives that attain CSA-specific groundwater remediation levels within varying time periods using one or more different technologies. Groundwater presumptive remedies may be included if supported by characterization data. If applicable, one or more innovative technologies as components of alternatives may be included such as in situ treatment of a hot spot using injected reagent

### **5.9.5 Refine Alternatives**

Alternatives will be refined to allow for efficient differentiation with respect to effectiveness, implementability, and cost. The effect of source control actions on areas with significantly elevated concentrations of COPCs and their effect on the timeframe to achieve groundwater remediation levels will be determined. The refined volumes of impacted groundwater will be used to refine sizing of process options and the associated alternatives. Further refinements to process options and alternatives will be completed based on revised/updated groundwater concentrations of COPCs and their PRGs and the updated timeframes for operation of the alternatives. The alternatives will be modified for each COPC to incorporate new risk information in the baseline risk assessment. Action-specific preliminary ARARs will be updated as remedial alternatives are refined.

### **5.9.6 Develop Final Alternatives**

Based on these refinements, a list of final alternatives to be carried forward into the detailed analysis of alternatives that will be developed. Alternatives will be selected based on:

- Short-term and long-term effectiveness in terms of reductions in toxicity, mobility, or volume
- Implementability in terms of the technical and administrative feasibility of constructing, operating, and maintaining the alternative
- Cost including both capital expenditures and operating expenditures and net present worth to evaluate expenditures that occur over different time periods

Only the alternatives with the most favorable composite evaluation will be summarized, retained, presented, and submitted with the alternatives development and screening technical memorandum. This memorandum will include the rationale used for screening and eliminating alternatives, a summary of the alternatives that remain, and the action-specific ARARs and rationale used to develop them. Upon submittal of this memorandum, a meeting to discuss results and receive comments will be scheduled with EPA. The memorandum will then be revised to address comments and resubmitted.

## 5.10 Detailed Analysis of Remedial Alternatives

The primary objective of the final phase of the FS, the detailed analysis of remedial alternatives, will be to review the list of potentially implementable FS alternatives that passed the screening stage and were approved in order to provide EPA with the necessary information to allow for remedy selection.

### 5.10.1 Analysis of Individual Alternatives

The relative performance of individual alternatives will be evaluated against seven criteria laid out in Title 40 *Code of Federal Regulations* Part 300.430(e)(9)(iii):

- Overall human health and the environment (threshold criterium)
- Compliance with ARARs (threshold criterium)
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

### 5.10.2 Comparative Analysis of Alternatives

Alternatives will then be compared against one another using the same criteria to assess the relative performance of each alternative. The results from the individual and comparative analysis will be summarized, and the relative strengths and weaknesses of each alternative in relation to the seven criteria listed above will be detailed within a draft comparative analysis report. These results will then be presented in a scheduled meeting.

As part of this analysis, a final comparison will be conducted of institutional controls. Institutional controls will be incorporated throughout the RI/FS process and will be evaluated against the nine criteria listed in the National Oil and Hazardous Substances Contingency Plan, which will include cost to implement, monitor, and/or enforce the institutional controls.

Identified and evaluated institutional controls will be summarized in a memorandum on the Alternatives Analysis for Institutional Controls and Screening. The memorandum will include objectives for institutional controls, the types of institutional controls that can be used to meet the RAOs, the timing and duration of institutional controls, and the agreements needed with the appropriate entities.

## 5.11 Feasibility Study Report

Once EPA accepts the results reported in the Alternatives Development and Screening memorandum, an FS report will be prepared in which the activities conducted during the development and screening of alternatives and the detailed analysis of alternatives are documented. The report will be prepared in accordance with the outline presented in the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988). Those activities include the following:

- Identification and Screening of Technologies
  - Development of RAOs
  - Development of general response actions
  - Identification and screening of technology types and process options
- Development and Screening of Alternatives
  - Development of alternatives

- Screening of alternatives
- Detailed Analysis of Alternatives
  - Individual analysis of alternatives
  - Comparative analysis of alternatives

The basis for the proposed plan to be developed by the EPA under CERCLA will also be summarized and reported. A draft FS report will be submitted to EPA for review and approval. All EPA comments will be addressed, and a revised FS report will be submitted for review and approval. It is noted that the FS report is subject to change following the public comment period, after which all comments pertinent to the content of the FS report will be addressed and a second revised report will be submitted to EPA for review and approval.

## 6. Schedule

Jacobs has prepared a project schedule for RI/FS implementation that begins with EPA approval of this RI/FS work plan and ends with EPA approval of the FS report, a period of 64 months. The project schedule is provided as Appendix C to this work plan. The sections below summarize the sequence of work.

### 6.1 Scoping

Project scoping is completed after review and approval by EPA of the plans associated with project scoping including this work plan and the reports and plans detailed in Section 1.

### 6.2 Remedial Investigation – Study Area Characterization (Field Efforts)

The RI includes Phase 1 (surface geophysics) followed by an addendum to the FSP that includes a summary of the surface geophysics data and interpretation and borehole locations and plans for groundwater monitoring wells. This addendum will be prepared with recommended borehole locations and will be finalized after EPA review and approval.

Phase 2 (drilling, downhole geophysics, hydrogeologic characterization, and well construction) will be performed at locations determined at the conclusion of Phase 1.

Phase 3 (groundwater monitoring for eight consecutive quarters) will start at the conclusion of Phase 2 and after wells are completed and developed.

### 6.3 Preliminary RAAs, RAOs, and ARARs

Formulation of the RAAs, RAOs, and ARARs will be performed using the data obtained from the RI field investigation, including the groundwater monitoring results. The preliminary RAAs, RAOs, and ARARs will be submitted to EPA at the same time as the Preliminary Study Area Characterization Report.

### 6.4 Baseline Risk Assessment

The information developed in the preliminary study area characterization report will be used as the basis for the risk assessment, with an initial scoping meeting planned to kick off this effort.

As described in Section 5.6, a BERA problem formulation report will be prepared for EPA review and is likely to show that potential exposure pathways from groundwater to ecological receptors are incomplete, eliminating the need for a BERA.

### 6.5 Remedial Investigation Report

At the conclusion of the risk assessment evaluation, the RI report will be prepared and will incorporate the Preliminary Study Area Characterization Report; this report will summarize the current sources, nature, and extent of COCs and the fate and transport of COCs in groundwater along with an updated CSM.

The numerical groundwater flow model and constituent fate and transport model will be incorporated into the RI report and model results will be incorporated into the updated CSM.

## **6.6      Treatability Studies**

Early in the RI, the candidate technologies memorandum for treatability studies (Jacobs, 2021c) will be reviewed by EPA and a determination made as to the need for treatability studies to evaluate potential remedial alternatives. Associated with this may be the need for a literature survey of the candidate technologies to aid in this decision.

## **6.7      Feasibility Study**

Upon approval of the HHRA and ecological risk process (at whichever BERA step that terminates), an FS meeting will be held to kick off the FS.

A technical memorandum on alternatives development and screening will be prepared, along with a draft report on comparative analysis of the remedial alternatives; this will conclude with the preparation and approval of an FS report.

## 7. Project Management Plan

The RI/FS work plan will be implemented by the CSA Working Group and its contractor, Jacobs, and the EPA and State of New Mexico RI/FS Technical Team. A project management structure has been developed to allow for the successful implementation of the RI/FS work plan using streamlined communications between EPA, the Working Group, and Jacobs. Internal to Jacobs, quality and technical lead personnel have been identified and assigned to the project.

The project organization is meant to foster effective and efficient project operations. Effectiveness refers to the ability to meet the project goals. Efficiency refers to accomplishing the desired outcome with a minimum amount of time and effort by employing the appropriate delivery means and methods. Effective and efficient qualities are developed when all members of the management team and their specific project teams understand the goals and how they apply to the work.

Disseminating this understanding through work planning and instruction documents such as this RI/FS work plan and the SAP (Jacobs, 2021a) means that the project manager and team members are able to make decisions that affect the project and activities on the basis of sound judgment because they see how decisions affect overall project goals. It also means that the project manager and team members are able to recognize when a decision lies within an area of project risk and, therefore, requires engagement and input from higher levels within the Working Group, contractor, and EPA organizations. This results in decision making at the appropriate levels within the project team that contributes to effective and efficient project operation and attainment of project goals.

### 7.1 Working Group and Jacobs Personnel

The Working Group is led by a project coordinator who is the primary point of contact with the EPA remedial project manager and the Jacobs project manager. The project coordinator manages the administrative details and coordinates the technical deliverables required by the AOC. Jacobs maintains subject matter experts in the fields required to support this project such as geochemistry, hydrogeology, geophysics, and feasibility and treatability studies. These subject matter experts and other technical resources have been identified and assigned to the project by the Jacobs project manager to implement the RI/FS work plan and associated supporting documents such as the SAP and the Health and Safety Plan. Junior technical resources are assigned to support the Jacobs senior staff in delivering the technical details of the project. Additional details regarding the management and implementation of this RI/FS are provided in the draft Quality Management Plan (Jacobs, 2020).

Individuals who will represent the Working Group and Jacobs for project management, senior technical support, and field support to the CSA project are shown below.

| Personnel       | Organization      | Project Role   |
|-----------------|-------------------|--|
| Daniel Lattin   | CSA Working Group | Project Coordinator  |
| Jeffrey Minchak | Jacobs            | Project Manager  |
| Steven Martz    | Jacobs            | Quality Assurance Manager  |
| Aleeca Forsberg | Jacobs            | Field and Logistical Support                                       |
| Jeff Gillow     | Jacobs            | Senior Technical Consultant and Geochemistry Subject Matter Expert |
| Pete Lawson     | Jacobs            | Groundwater and Hydrogeology Subject Matter Expert                 |

| <b>Personnel</b> | <b>Organization</b> | <b>Project Role</b>                                   |
|------------------|---------------------|---|
| Neil McKay       | Jacobs              | Geophysics Subject Matter Expert                      |
| Jim Stefanoff    | Jacobs              | FS and Treatability Study Subject Matter Expert       |
| Bernice Kidd     | Jacobs              | Quality Assurance and Analytical Support              |
| Jessy Kastanek   | Jacobs              | Human Health Risk Assessor                            |
| Jon Russ         | Jacobs              | Ecological Risk Assessor                              |
| Kari MacGregor   | Jacobs              | Data Management Support                               |
| Jessica Lin      | Jacobs              | Field Sampling Support – Geophysical Investigation    |
| McKenze Booth    | Jacobs              | Field Sampling Support – Drilling and Aquifer Testing |

## 7.2 EPA and State of New Mexico RI/FS Technical Team Personnel

In accordance with CERCLA, the National Contingency Plan, and the AOC/SOW, NMED is the designated state support agency to EPA for all CERCLA response actions to be conducted at the CSA. The NMED and the Mining and Minerals Division of the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) are the state agencies that will review all deliverables under the AOC and SOW, as well as attend meetings and provide overall support and expertise to EPA in overseeing the performance of the RI/FS by the Working Group and its contractors. These members are considered part of the regulatory technical team involved with all aspects of the RI/FS. EPA's oversight contractor, Weston Solutions, Inc., is also part of the regulatory team.

| <b>Personnel</b>     | <b>Organization</b>                                  | <b>Project Role</b>  |
|----------------------|--|--|
| Mark Purcell         | EPA Region 6   | Project Manager  |
| Nathaniel Applegate  | EPA Region 6   | Alternate Project Manager                                    |
| Janet Brooks         | EPA Region 6   | Technical Support – Remedial Project Manager                 |
| Ashley Chang         | EPA Region 6   | Technical Support – Remedial Project Manager                 |
| Kurt Vollbrecht      | NMED – Mining<br>Environmental<br>Compliance Section | Program Manager  |
| William Pearson      | NMED – Superfund<br>Oversight Section                | Project Manager  |
| Dr. Patrick Longmire | NMED   | Senior Technical Support and Principal Aqueous<br>Geochemist |
| Holland Shepherd     | EMNRD – Mining and<br>Minerals Division              | Program Manager, Mining Act Reclamation Program              |
| Jeff Criner          | Weston Solutions, Inc.                               | Project Manager  |
| Dr. Dong Ding        | Weston Solutions, Inc.                               | Senior Project Hydrologist/Geochemist                        |

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## Tables

Table 2-1. Summary Statistics, Water Quality by Geographic Area in the CSA  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

| Area                               | Aquifer                 | Analyte:                                     | Sodium<br>(mg/L) | Calcium<br>(mg/L) | Chloride<br>(mg/L) | Bicarbonate<br>(mg/L) | Sulfate<br>(mg/L) | Selenium<br>(mg/L) | Uranium<br>(mg/L) |
|------------------------------------|-------------------------|--|------------------|-------------------|--------------------|-----------------------|-------------------|--------------------|-------------------|
| Upper CSA Hydrostratigraphic Units | Upper CSA Alluvium Area | East of Crossroads                           |                  |                   |                    |                       |                   |                    |                   |
|                                    |                         | Average:                                     | 147              | 45                | 16                 | 307                   | 123               | 0.022              | 0.183             |
|                                    |                         | Standard Deviation:                          | 12               | 3                 | 1                  | 6                     | 6                 | 0.001              | 0.015             |
|                                    |                         | Median:                                      | 140              | 45                | 16                 | 310                   | 120               | 0.022              | 0.180             |
|                                    |                         | Range:                                       | 140 - 160        | 42 - 48           | 15 -17             | 300 - 310             | 120 - 130         | 0.021 - 0.022      | 0.17 - 0.20       |
|                                    |                         | Southwest Crossroads                         |                  |                   |                    |                       |                   |                    |                   |
|                                    |                         | Average:                                     | 227              | 351               | 40                 | 132                   | 1518              | 0.013              | 0.020             |
|                                    |                         | Standard Deviation:                          | 119              | 248               | 13                 | 74                    | 1203              | 0.007              | 0.002             |
|                                    |                         | Median:                                      | 240              | 478               | 45                 | 168                   | 2030              | 0.013              | 0.021             |
|                                    |                         | Range:                                       | 102 - 339        | 65.9 - 510        | 26 - 49.8          | 47 - 181              | 144 - 2380        | 0.006 - 0.021      | 0.017 - 0.021     |
|                                    | Upper CSA Bedrock Area  | Dakota Sandstone Formation                   |                  |                   |                    |                       |                   |                    |                   |
|                                    |                         | Average:                                     | 217              | 431               | 52                 | 184                   | 1810              | 0.026              | 0.018             |
|                                    |                         | Standard Deviation:                          | 47               | 243               | 11                 | 6                     | 1006              | 0.009              | 0.009             |
|                                    |                         | Median:                                      | 220              | 490               | 55                 | 180                   | 2100              | 0.027              | 0.013             |
|                                    |                         | Range:                                       | 143 - 270        | 7.07 - 610        | 33 - 59            | 180 - 192             | 49 - 2500         | 0.017 - 0.032      | 0.01 - 0.029      |
|                                    |                         | Morrison Formation - Westwater Canyon Member |                  |                   |                    |                       |                   |                    |                   |
|                                    |                         | Average:                                     | 78               | 195               | 19                 | 216                   | 596               | 0.003              | 0.013             |
|                                    |                         | Standard Deviation:                          | 56               | 171               | 20                 | 45                    | 713               | 0.001              | 0.015             |
|                                    |                         | Median:                                      | 78               | 195               | 19                 | 216                   | 596               | 0.003              | 0.013             |
|                                    |                         | Range:                                       | 38.5 - 118       | 74.6 - 316        | 12175              | 184 - 248             | 91 - 1100         | 0.002 - 0.004      | 0.002 - 0.023     |
| Lower CSA Hydrostratigraphic Units | Lower CSA Alluvium Area | North SMC Floodplain                         |                  |                   |                    |                       |                   |                    |                   |
|                                    |                         | Average:                                     | 330              | 311               | 88                 | 210                   | 1478              | 0.302              | 0.157             |
|                                    |                         | Standard Deviation:                          | 116              | 129               | 31                 | 39                    | 361               | 0.127              | 0.078             |
|                                    |                         | Median:                                      | 320              | 386               | 81                 | 211                   | 1600              | 0.290              | 0.150             |
|                                    |                         | Range:                                       | 200 - 613        | 34.8 - 420        | 58 - 142           | 140 - 280             | 727 - 2200        | 0.11 - 0.581       | 0.031 - 0.232     |
|                                    |                         | East & West of Floodplain                    |                  |                   |                    |                       |                   |                    |                   |
|                                    |                         | Average:                                     | 303              | 119               | 78                 | 38                    | 921               | 0.007              | 0.002             |
|                                    |                         | Standard Deviation:                          | 33               | 33                | 1                  | 33                    | 44                | 0.006              | 0.001             |
|                                    |                         | Median:                                      | 290              | 106               | 78                 | 31                    | 911               | 0.004              | 0.002             |
|                                    |                         | Range:                                       | 278 - 341        | 94.0 - 156        | 77 - 78            | 27303                 | 882 - 969         | 0.003 - 0.013      | 0.0003 - 0.002    |

Table 2-1. Summary Statistics, Water Quality by Geographic Area in the CSA  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

| Area                               | Aquifer                 | Analyte:             | Sodium<br>(mg/L) | Calcium<br>(mg/L) | Chloride<br>(mg/L) | Bicarbonate<br>(mg/L) | Sulfate<br>(mg/L) | Selenium<br>(mg/L) | Uranium<br>(mg/L) |
|------------------------------------|-------------------------|----------------------|------------------|-------------------|--------------------|-----------------------|-------------------|--------------------|-------------------|
| Lower CSA Hydrostratigraphic Units | Lower CSA Alluvium Area | South SMC Floodplain |                  |                   |                    |                       |                   |                    |                   |
|                                    |                         | Average:             | 278              | 317               | 59                 | 203                   | 1361              | 0.403              | 0.033             |
|                                    |                         | Standard Deviation:  | 21               | 64                | 9                  | 41                    | 300               | 0.235              | 0.015             |
|                                    |                         | Median:              | 274              | 338               | 57                 | 210                   | 1435              | 0.431              | 0.026             |
|                                    |                         | Range:               | 253 - 315        | 234 - 385         | 49 - 73            | 152 - 246             | 988 - 1770        | 0.125 - 0.659      | 0.0204 - 0.053    |
|                                    | Lower CSA Bedrock Area  | Chinle Group         |                  |                   |                    |                       |                   |                    |                   |
|                                    |                         | Average:             | 2464             | 396               | 5444               | 317                   | 843               | 0.014              | 0.025             |
|                                    |                         | Standard Deviation:  | 3193             | 591               | 9469               | 390                   | 216               | 0.015              | 0.031             |
|                                    |                         | Median:              | 680              | 93                | 476                | 240                   | 870               | 0.012              | 0.002             |
|                                    |                         | Range:               | 420 - 7700       | 12 - 1400         | 50 - 24000         | 34 - 1169             | 610 - 1100        | 0.0004 - 0.042     | 0.0011 - 0.064    |

Notes:

CSA = Central Study Area

mg/L = milligram(s) per liter

SMC = San Mateo Creek

**Table 4-1: Data Quality Objective 1 – Hydrogeology of the CSA**

*San Mateo Creek Basin Groundwater Site: Central Study Area*

*Cibola and McKinley Counties, New Mexico*

Within the CSA, characterize the hydrogeological properties of the alluvial sediments and bedrock aquifers to identify the principal groundwater flow paths, flow rates, and vertical hydraulic gradients between the saturated alluvial sediments and bedrock systems.

|   |  |
|---|--|
| 1. State the Problem                              | The lithologic and hydraulic properties of the alluvial sediments and bedrock aquifers, in terms of the distribution and occurrence of gravel, sand, silt, clay, and fractures in bedrock, and resultant hydraulic conductivity distribution and storage properties, and vertical gradients, requires better definition, specifically at locations within the CSA important for groundwater and constituent movement. Groundwater that moves through higher permeability flow paths in the sediments and bedrock, and vertically from the alluvial sediments to bedrock, will potentially transit the CSA more rapidly and distribute COPCs through the CSA.   |
| 2. Identify the Goal of the Study                 | What are the principal groundwater flow paths and rates within the alluvial sediments and bedrock aquifers?<br><br>What is the vertical hydraulic gradient between the saturated alluvial sediments and bedrock system?  |
| 3. Identify Information Inputs                    | <ul style="list-style-type: none"><li>• Surface geophysics (electrical resistivity transect and seismic reflection) for determining lithologic variability over large (hundreds of feet) scales, including defining the top of bedrock structure</li><li>• Historical groundwater elevation data</li><li>• Borehole drilling including drilling methodology, and borehole cores and drill cuttings to identify depths to the base of the alluvium and tops of bedrock for preparation of lithological boring logs and detailed mapping and structure</li><li>• Borehole geophysics for determining lithologic variability over small (2- to 5-foot) scales, including defining the top of bedrock structure</li><li>• Aquifer tests to evaluate hydraulic conductivity of alluvial sediments and bulk bedrock units</li><li>• Packer tests to evaluate hydraulic conductivity of bedrock fracture zones</li><li>• Sediment analysis to evaluate particle sizes</li><li>• Water level measurements obtained over eight consecutive quarters</li><li>• Available information about existing wells and associated lithologic logs</li></ul> |
| 4. Define the Scope of the Study                  | Current hydrogeological conditions in the CSA in the unconsolidated saturated alluvial sediments and bedrock aquifers across the alluvial valley and longitudinally through the north to south section of the CSA. Focus areas are the upper CSA at the Crossroads (west [Arroyo del Puerto] and east (San Mateo Creek)] and longitudinally and laterally within the central and lower portion of the CSA.   |
| 5. Develop the Analytic Approach                  | The hydrogeological study will characterize the average hydraulic properties and spatial variability of the alluvial sediments and bedrock aquifers and identify the principal groundwater transport pathways through the alluvial sediments and bedrock aquifer systems. Hydraulic property information will also be used to develop a numerical groundwater model to simulate the hydraulic properties of the saturated alluvial sediments and bedrock aquifer systems within the CSA and to evaluate exposure pathways and remedial alternatives.   |
| 6. Specify the Performance or Acceptance Criteria | The groundwater model will undergo calibration and a sensitivity analysis to evaluate model performance and its appropriateness for simulating groundwater movement within the CSA.<br><br>This phase of work is a non-statistical approach; professional judgment focused on meeting data quality objectives will be used to evaluate decision error tolerance.   |
| 7. Develop the Plan for Obtaining Data            | The elements of the remedial investigation associated with characterization of the hydraulic properties of the alluvial sediments and bedrock aquifer describe the plan for data acquisition and analysis.   |

**Table 4-2: Data Quality Objective 2 – Role of the San Mateo Fault Zone in Groundwater Movement in the CSA**

*San Mateo Creek Basin Groundwater Site: Central Study Area*

*Cibola and McKinley Counties, New Mexico*

Role of the San Mateo Fault Zone in Groundwater Movement in the CSA– Within the CSA, understand how the geologic structures across the San Mateo Fault Zone influence groundwater movement.

|   |  |
|---|--|
| 1. State the Problem                              | Geologic structures along the San Mateo Fault Zone within bedrock cause offsets in the contacts between individual bedrock water bearing units and affect the contacts between the alluvial sediments and individual bedrock units. These structures are not currently understood in sufficient detail at locations critical for understanding groundwater movement across the CSA and they will influence groundwater and contaminant of potential concern distribution across the study area. This data need is specific to the role that the San Mateo Fault Zone plays in influencing groundwater movement.  |
| 2. Identify the Goal of the Study                 | What is the geologic structure of faults within the CSA in the Crossroads Area and through the longitudinal axis of the CSA associated with the San Mateo Fault Zone?<br>How do these structures influence groundwater movement in the bedrock aquifer system and exchange between saturated alluvial sediments and bedrock groundwater?   |
| 3. Identify Information Inputs                    | <ul style="list-style-type: none"><li>• Surface geophysics (seismic reflection studies) across the San Mateo Fault Zone to identify faults within the bedrock units and to identify the top of bedrock structure</li><li>• Electrical resistivity transect studies to evaluate faults within the depth of bedrock immediately below the saturated alluvial sediments and to characterize the contact with the alluvium where groundwater flow pathways may be affected by faults and offsetting bedrock units</li><li>• Borehole geophysics to characterize bedrock faults and water-bearing units affected by faulting and to define the top of bedrock structure</li><li>• Borehole lithologic logging to identify the top of bedrock structure and faults and presence of fault gouge; these data will assist in identification of structural features that may act as preferential groundwater flow paths or represent barriers to groundwater flow.</li><li>• Groundwater elevation data</li><li>• Aquifer hydraulic tests</li><li>• Local geologic information from published sources including the U.S. Geological Survey, New Mexico Bureau of Geology and Mineral Resources, and industry-prepared technical reports.</li></ul> |
| 4. Define the Scope of the Study                  | Current geologic conditions within the CSA in the bedrock aquifer units and contact with the alluvial sediments.   |
| 5. Develop the Analytic Approach                  | The results of the surface geophysics (electrical resistivity transect and seismic reflection) investigation will be used to guide borehole placement with specific borehole locations identified for the purpose of investigating the San Mateo Fault Zone and its role in groundwater movement. The geological study will enhance the current understanding of the San Mateo Fault Zone at key locations to understand the hydrogeological conditions within the bedrock aquifers and contacts with the alluvial sediments. Structural maps will be prepared based upon the surface and borehole geophysics results, along with lithologic data and existing data and maps.  |
| 6. Specify the Performance or Acceptance Criteria | This phase of work is a non-statistical approach; professional judgment focused on meeting data quality objectives will be used to evaluate decision error tolerance.  |
| 7. Develop the Plan for Obtaining Data            | The elements of the remedial investigation associated with characterization of the geologic structure of the bedrock aquifer describe the plan for data acquisition and analysis.  |

**Table 4-3: Data Quality Objective 3 – Background Geochemical Conditions and Water Quality within the CSA**

*San Mateo Creek Basin Groundwater Site: Central Study Area*

*Cibola and McKinley Counties, New Mexico*

Geochemistry of the CSA – Characterize the background water quality conditions within the alluvial sediments and bedrock aquifers.

|                                   |   |
|-----------------------------------|---|
| 1. State the Problem              | The water quality associated with groundwater in the saturated alluvial sediments and bedrock aquifers is currently not well known within the CSA; a better understanding of background water quality is needed to evaluate the concentration of constituents present within the CSA due background conditions.   |
| 2. Identify the Goal of the Study | <p>What is the background water quality of the saturated alluvial sediments and bedrock aquifer?</p> <p>What concentrations of naturally occurring constituents are present in sediments and bedrock materials?</p>   |
| 3. Identify Information Inputs    | <ul style="list-style-type: none"><li>• Borehole development and lithologic logging through the alluvial sediments (unsaturated and saturated zone materials) and into bedrock materials</li><li>• Saturated and unsaturated sediment sampling and geochemical (total elemental composition and leachable trace elements) and mineralogical analyses (petrographic analysis [light microscopy], X-ray diffraction, scanning electron microscopy, and energy dispersive spectroscopy)</li><li>• Samples collected from a range of sediment lithologies to assess the differences in COPC concentrations within a range of sediment types in the CSA</li><li>• Determination of constituent concentrations and major ion and trace element concentrations of groundwater across the CSA</li><li>• Laboratory column tests using site groundwater and soil</li><li>• Major cations and anions including fluoride, TDS, and trace elements and COPCs including arsenic, barium, boron, iron manganese, uranium, selenium, nitrate, vanadium, radionuclides, and other solutes in groundwater</li><li>• Trace metals/elements in groundwater and soil</li><li>• Stable isotopes of oxygen, hydrogen, carbon, nitrogen, and sulfur in groundwater</li><li>• Dual stable isotopes of nitrogen-15/14, and oxygen-18/16 in nitrate and sulfur-34/32 and oxygen-18/16 in sulfate in groundwater, and deuterium and oxygen-18 in water.</li><li>• Total organic carbon (TOC) and dissolved organic carbon (DOC)</li><li>• Field parameters (pH, ORP, DO, temperature, conductivity, turbidity)</li><li>• Parent and daughter radionuclides, including radiogenic isotopes of radium and uranium, tritium and carbon-14 in groundwater; uranium activity ratio analyses</li><li>• Existing data developed by the U.S. Environmental Protection Agency and by Homestake Mining Company of California at the lower CSA boundary</li></ul> |
| 4. Define the Scope of the Study  | Current background water quality conditions within the alluvial sediments and underlying bedrock aquifer units; groundwater chemical analysis over a 2-year period to capture seasonal fluctuations in chemical composition and constituent concentrations  |

|  |   |
|--|---|
| <p>5. Develop the Analytic Approach</p>                  | <p>The geochemical and mineralogical study will determine the average (mean) composition and concentration of major and minor elements in alluvial sediments and bedrock materials at key locations within the CSA (with the locations determined based on the results of the geophysics evaluation) along with the leaching behavior (mobile fraction) of these elements and their ability to leach to groundwater. Laboratory column tests will evaluate dissolution and precipitation of constituents in groundwater and soil using lower solid:solution ratios (e.g., 0.3 to 1) as compared to leach tests. Geochemical modeling will provide aqueous speciation, acid-base reactions, oxidation-reduction, mineral precipitation/dissolution, and adsorption/desorption (surface complexation modeling). The geochemical modeling software PHREEQC will help quantify the sources (dissolution) and the sinks (precipitation/sorption) of COPCs in the aquifer system. The groundwater analyses will determine the average (mean) chemical composition and constituent concentrations associated with background conditions and the 95% upper tolerance limit (UTL) of the background data set at 95% coverage (UTL 95-95)</p> |
| <p>6. Specify the Performance or Acceptance Criteria</p> | <p>Data will be collected to estimate the mean chemical properties of the sediments, bedrock materials, and groundwater; the relative standard error of the mean will be determined to assess the representativeness of the data collected.</p>   |
| <p>7. Develop the Plan for Obtaining Data</p>            | <p>The elements of the remedial investigation associated with characterization of the geochemical properties of the alluvial sediments and bedrock materials, and groundwater chemical characteristics, describe the plan for data acquisition and analysis.</p>  |

**Table 4-4: Data Quality Objective 4 – COPC Distribution, Trends and Transport within the CSA**

*San Mateo Creek Basin Groundwater Site: Central Study Area*

*Cibola and McKinley Counties, New Mexico*

Geochemistry of the CSA – Characterize the distribution of COPC concentrations spatially and temporally, the hydrogeological and geochemical basis for this distribution, and transport properties of COPCs through the CSA.

|   |  |
|---|--|
| 1. State the Problem                              | Constituent of potential concern (COPC) distribution in groundwater across the CSA was last estimated in 2016 with a limited data set. The distribution of constituents and their concentration trends with time is not adequately understood in terms of the basis for the current distribution and trends in concentration; this includes the transport properties of COPCs in groundwater through the CSA. This data gap exists for COPCs both in saturated alluvial sediments and in bedrock groundwater.  |
| 2. Identify the Goal of the Study                 | What is the current distribution of groundwater COPCs within the CSA?<br>How do concentrations of COPCs in groundwater change seasonally over a 2-year period of monitoring?<br>How do COPCs partition to mineral phases in sediments and bedrock materials?   |
| 3. Identify Information Inputs                    | <ul style="list-style-type: none"><li>• Groundwater samples obtained from wells installed in saturated alluvial sediments and bedrock aquifers, with wells installed at key locations within the CSA to capture the spatial variability in COPC concentrations</li><li>• Groundwater samples obtained from existing wells within the CSA; with wells chosen based on the availability of information about well integrity and screened interval depths and lithologies</li><li>• Groundwater samples obtained over 2 years, with eight consecutive quarters of groundwater sampling to understand seasonal variability in COPC concentrations and trends over time</li><li>• Geochemical analysis of soils including mineralogy</li><li>• Geochemical analysis of groundwater as described for DQO 3.</li><li>• Laboratory column tests using site groundwater and soil</li><li>• Geochemical and hydrogeological modeling of COPC groundwater transport characteristics in the saturated alluvial sediments and bedrock aquifers</li><li>• Compilation and review of all available data for locations within the CSA</li></ul>  |
| 4. Define the Scope of the Study                  | Current water quality conditions within the CSA in the saturated alluvial sediments and bedrock aquifer units.   |
| 5. Develop the Analytic Approach                  | The analysis of groundwater constituents through sampling of new and existing groundwater wells will determine the concentration distribution across the CSA and over a 2-year period of time, with the mean concentration of COPCs determined at each monitoring well location and the UTL95-95 determined at each location. Laboratory column tests will evaluate dissolution and precipitation of constituents in groundwater and soil using lower solid:solution ratios (e.g., 0.3 to 1) as compared to leach tests. Geochemical modeling will provide aqueous speciation, acid-base reactions, oxidation- reduction, mineral precipitation/dissolution, and adsorption/desorption (surface complexation modeling). The geochemical modeling software PHREEQC will help quantify the sources (dissolution) and the sinks (precipitation/sorption) of COPCs in the aquifer system. Bivariate plots of COPC concentrations versus other cations and anions, etc. will be prepared. Groundwater fate and transport modeling of COPCs will be informed by soils characterization, column tests, and geochemical modeling work, with refinement of constituent retardation factors based upon the geochemical and hydrogeological modeling work. Water level data will be evaluated within the context of COPC concentrations in the CSA. |
| 6. Specify the Performance or Acceptance Criteria | Data will be collected to estimate the mean chemical properties of the sediments, bedrock materials, and groundwater; the relative standard error of the mean will be determined to assess the representativeness of the data collected.   |

|  |   |
|--|---|
| 7. Develop the Plan for Obtaining Data | The elements of the remedial investigation associated with characterization of the chemical constituents and COPC concentrations at well locations within the saturated alluvial sediments and bedrock aquifer describe the plan for data acquisition and analysis. |
|--|---|

**Table 4-5: Data Quality Objective 5 – Risk Assessment***San Mateo Creek Basin Groundwater Site: Central Study Area**Cibola and McKinley Counties, New Mexico*

Risk Assessment - Evaluate whether constituent concentrations in groundwater in the alluvium or bedrock aquifers within the CSA pose an unacceptable risk to human or ecological health.

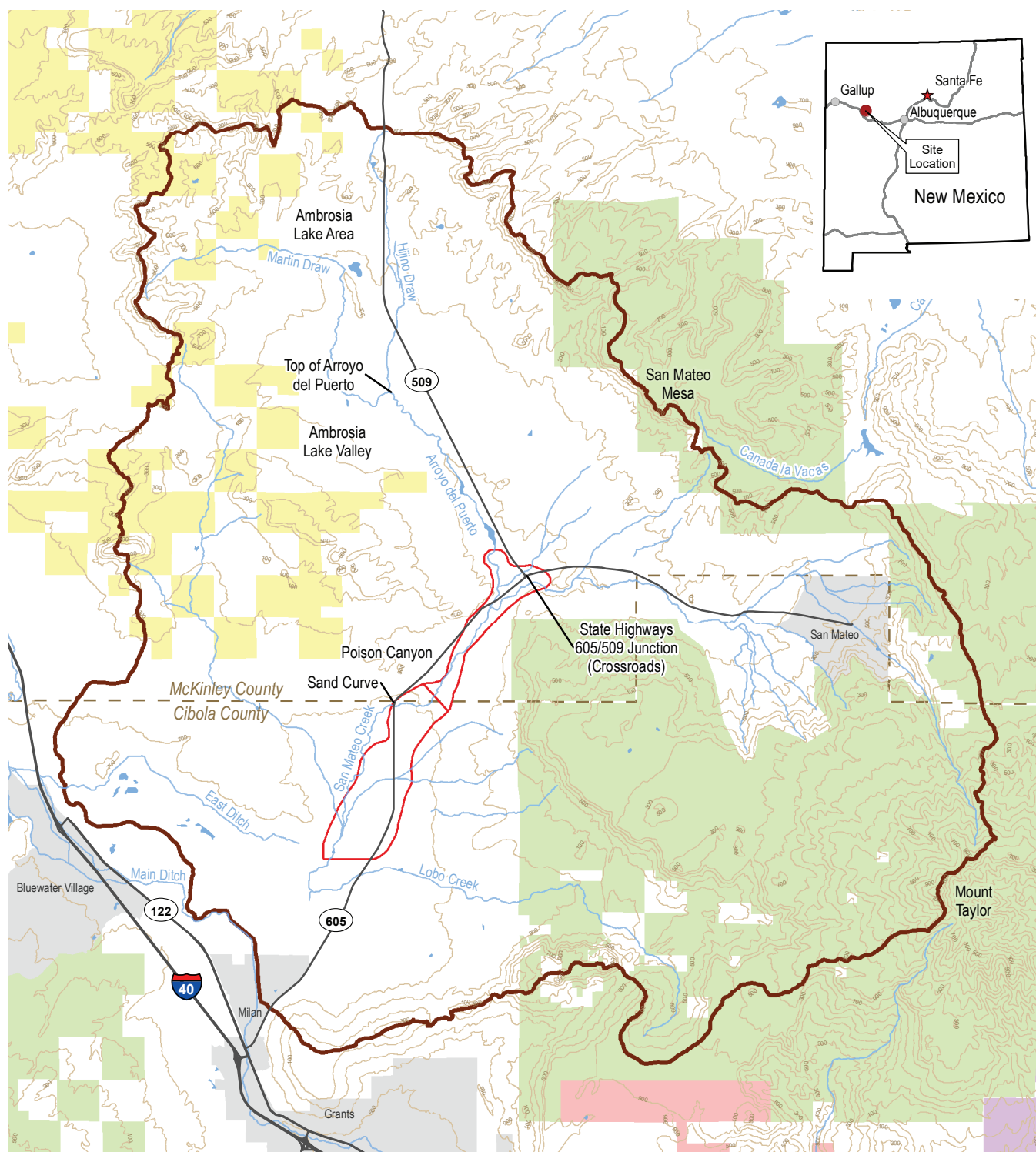
|   |   |
|---|---|
| 1. State the Problem                              | Groundwater within the CSA potentially contains constituents at concentrations above background and that present a risk to human or ecological health.  |
| 2. Identify the Goal of the Study                 | What is the risk to human and ecological health associated with groundwater exposure within the boundary of the CSA?  |
| 3. Identify Information Inputs                    | <ul style="list-style-type: none"><li>• Groundwater concentrations of COPCs.</li><li>• Applicable risk assessment guidance (EPA, 2001; EPA, 1989; EPA, 1991; EPA 2019a)</li><li>• The preliminary CSM (Jacobs, 2020a) identifying human and ecological receptors.</li><li>• Site-specific screening levels for residential ranchers exposed to COPCs in groundwater via tap water use and the ingestion of homegrown produce and livestock. Screening levels will be calculated based on the U.S. Environmental Protection Agency (EPA) Regional Screening Level calculator (EPA, 2019b) and conservative, site-specific assumptions.</li><li>• Background concentrations of COPCs.</li><li>• Groundwater COPC migration pathways in the CSA.</li><li>• Potential human and ecological receptors for groundwater within the CSA.</li><li>• Details about groundwater-related removal actions performed by EPA and others within and around the CSA.</li></ul> |
| 4. Define the Scope of the Study                  | Current groundwater use conditions in the CSA saturated alluvial sediments and bedrock aquifer units.   |
| 5. Develop the Analytic Approach                  | Risk estimates for potential exposure to COPCs in groundwater will be estimated for each individual sample location so as to represent a potential individual's exposure at any given location within the CSA. Refined risk estimates will also be calculated considering natural background concentrations of COPCs and upper confidence limits (UCLs) on the mean concentrations. COPC concentrations will be compared to site-specific Regional Screening Levels to estimate risk using the risk ratio approach (EPA 1989; EPA, 1991). Uncertainties in sample collection, analysis, and the risk assessment process will be detailed.   |
| 6. Specify the Performance or Acceptance Criteria | <ul style="list-style-type: none"><li>• Data identified as usable based on data validation will be included in the risk assessment.</li><li>• UCLs will be calculated using EPA ProUCL software (EPA, 2015).</li></ul>  |
| 7. Develop the Plan for Obtaining Data            | The elements of the remedial investigation associated with characterization of the geochemical and mineralogical composition of the saturated alluvial sediments and bedrock aquifer system provide the details of sample collection and analyses. The risk assessment approach described in the work plan provides the details of the data evaluation process that will be used to understand risk from groundwater to human and ecological health.  |

**Table 4-6: Data Quality Objective 6 – Feasibility Study***San Mateo Creek Basin Groundwater Site: Central Study Area**Cibola and McKinley Counties, New Mexico*

Feasibility Study – Develop and evaluate an appropriate range of groundwater alternatives that ensure protection of human health and the environment.

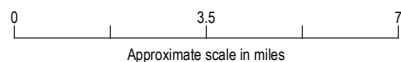
|   |   |
|---|---|
| 1. State the Problem                              | Remedial actions may be necessary if groundwater is found to contain constituents at concentrations above background that may pose a risk to human and ecological health.   |
| 2. Identify the Goal of the Study                 | Compile and compare appropriate range of groundwater remedial options that assure protection of human health and the environment. The range could include options in which treatment is used, options involving containment with little or no treatment, options involving both treatment and containment, and a no action alternative. An option for using point-of-use treatment at residential taps or wellheads or municipal supply drinking systems will also be considered.   |
| 3. Identify Information Inputs                    | <ul style="list-style-type: none"><li>• Remedial action objectives</li><li>• Results of the human health risk assessment and baseline ecological risk assessment</li><li>• Preliminary applicable or relevant and appropriate requirement (ARAR)</li><li>• Groundwater chemistry: major cations, major anions, constituents of potential concern, trace metals including aluminum, iron, manganese, barium, and strontium; fluoride, silica, pH total dissolved solids, oxidation reduction potential, and alkalinity</li><li>• Water chemistry trend over time</li><li>• Alternatives using in situ treatment: aerial extent, maximum flux, average flux, minimum flux, seasonal variation</li><li>• Alternatives using ex situ treatment: aerial extent of targeted groundwater, maximum flow rate, average flow rate, minimum flow rate, rate of flow variation</li><li>• Remedial water quality objectives</li><li>• Location</li><li>• Available utilities</li><li>• EPA guidance for conducting feasibility studies, including EPA, 1988.</li><li>• Hydrogeological model and fate and transport model.</li></ul> |
| 4. Define the Scope of the Study                  | Current groundwater quality conditions within the CSA in the saturated alluvial sediments and bedrock aquifer units.  |
| 5. Develop the Analytic Approach                  | General response actions will be identified, evaluated, screened, and then used to assemble alternatives. The alternatives will be refined, then compared individually against the seven criteria, and then against each other. Innovative technologies may be included if applicable.  |
| 6. Specify the Performance or Acceptance Criteria | <p>The relative performance of individual alternatives will be evaluated against seven criteria laid out in Title 40 <i>Code of Federal Regulations</i> 300.430(e)(9)(iii):</p> <ul style="list-style-type: none"><li>• Overall human health and the environment (threshold criterium)</li><li>• Compliance with ARARs (threshold criterium)</li><li>• Long-term effectiveness and permanence</li><li>• Reduction of toxicity, mobility, or volume through treatment</li><li>• Short-term effectiveness</li><li>• Implementability</li><li>• Cost</li><li>• Sustainability</li></ul>  |
| 7. Develop the Plan for Obtaining Data            | The processes and activities described in the approved RI/FS Workplan will be followed.   |

## Figures



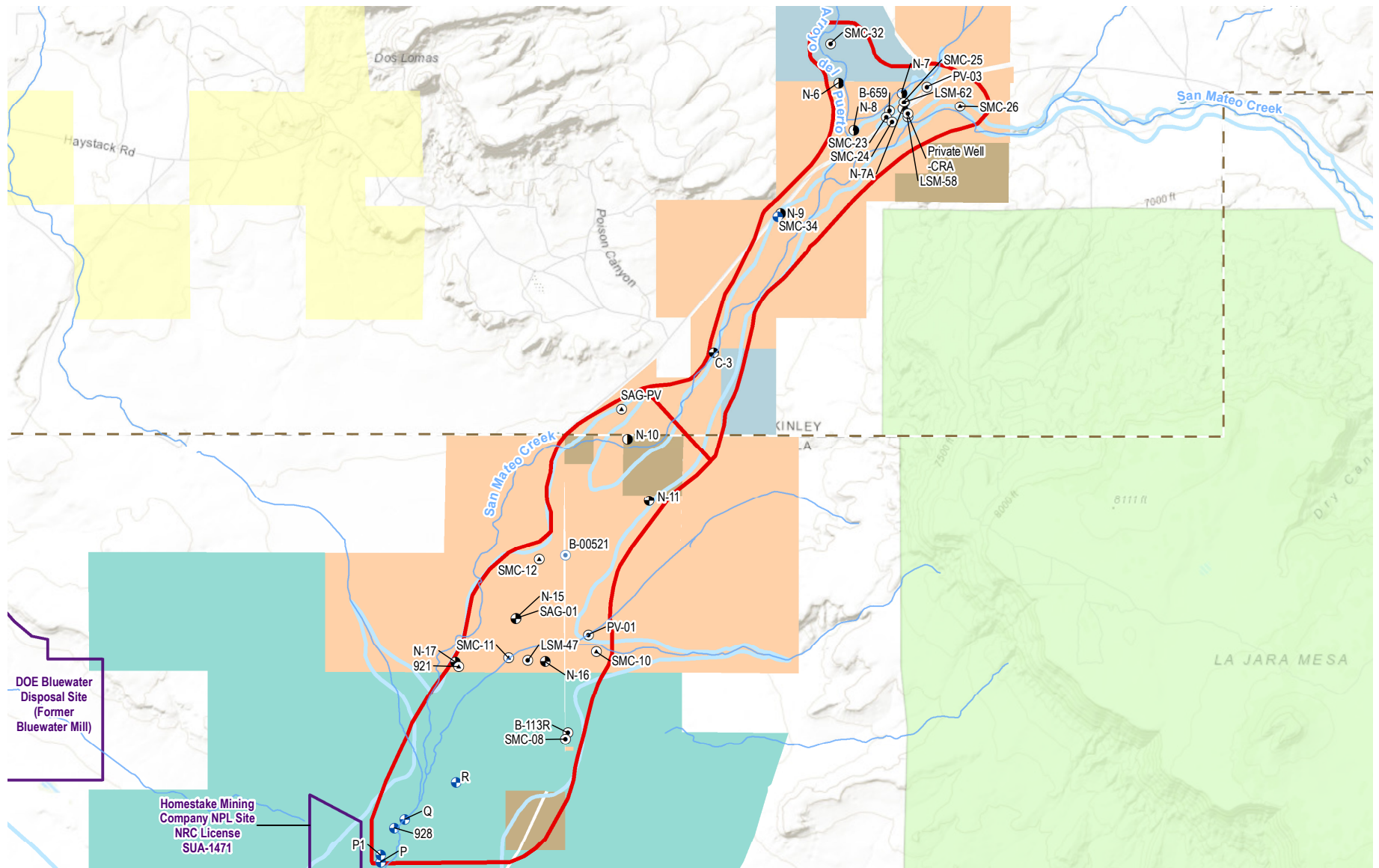
# LEGEND

- Elevation Contour (Feet)
- Central Study Area
- San Mateo Creek Basin
- Acoma Pueblo
- Laguna Pueblo
- Navajo Nation Tribal Land
- U.S. Forest Service Land
- Municipal Land



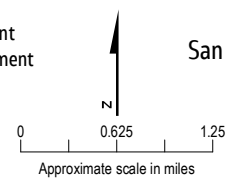
**Figure 2-1. General Location Map**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

**Jacobs**



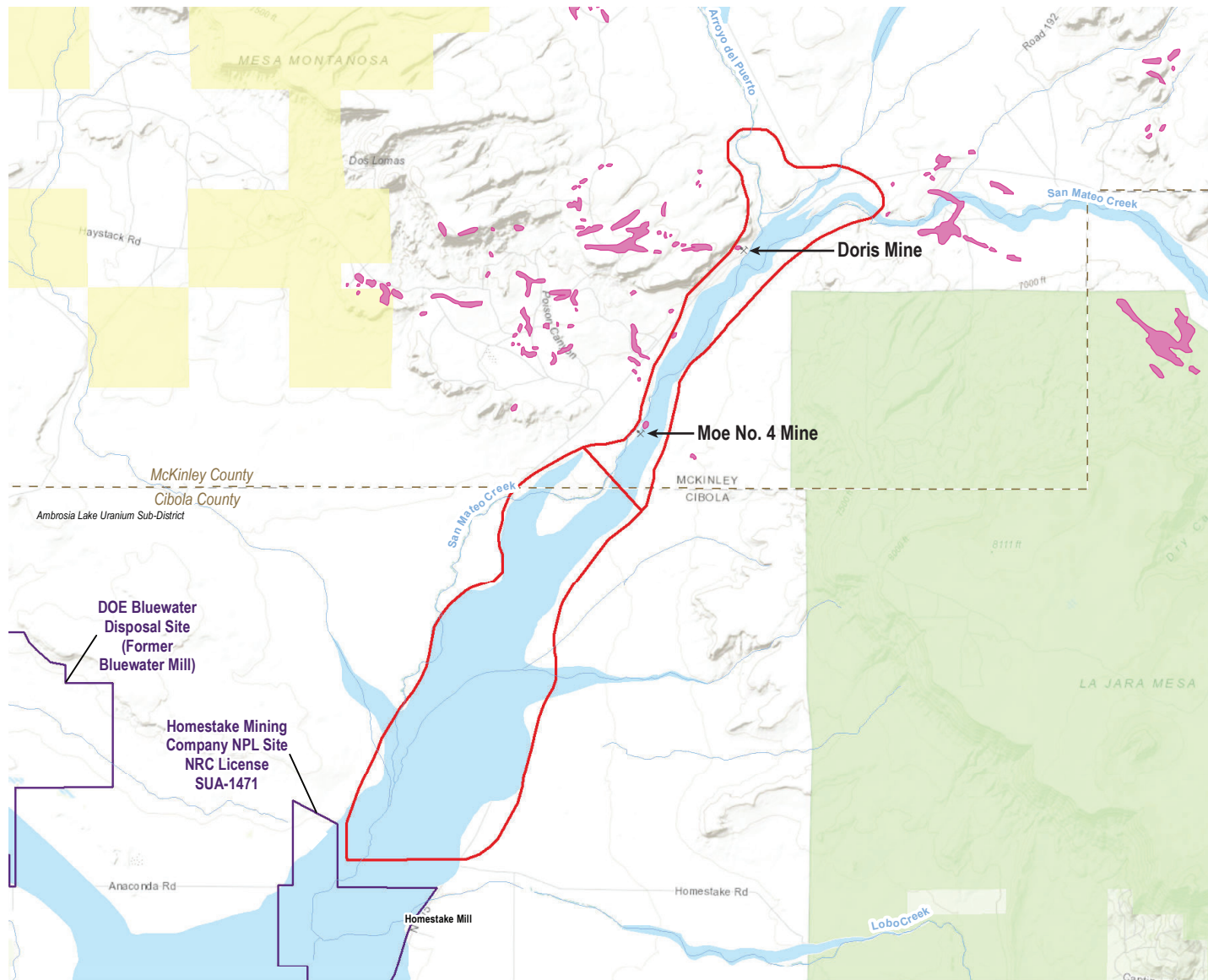
# LEGEND

- EPA Dry Borehole
- ⊕ EPA Monitoring Well
- ⊕ Industry Monitor Well
- ⊕ Private Domestic Well
- ⊕ Private Livestock Well
- ⊕ Private Well
- Surface Water Line
- County Boundary Line
- Study Area
- HMC Controlled Area Boundary
- Navajo Nation Tribal Land
- U.S. Forest Service Land
- Private Land Homestake Mining of California
- State Land
- United States Government Bureau of Land Management
- Estimated Boundary of Saturated Alluvium (2015-2018)



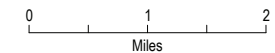
**Figure 2-2. Site Location Map**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

**Jacobs**



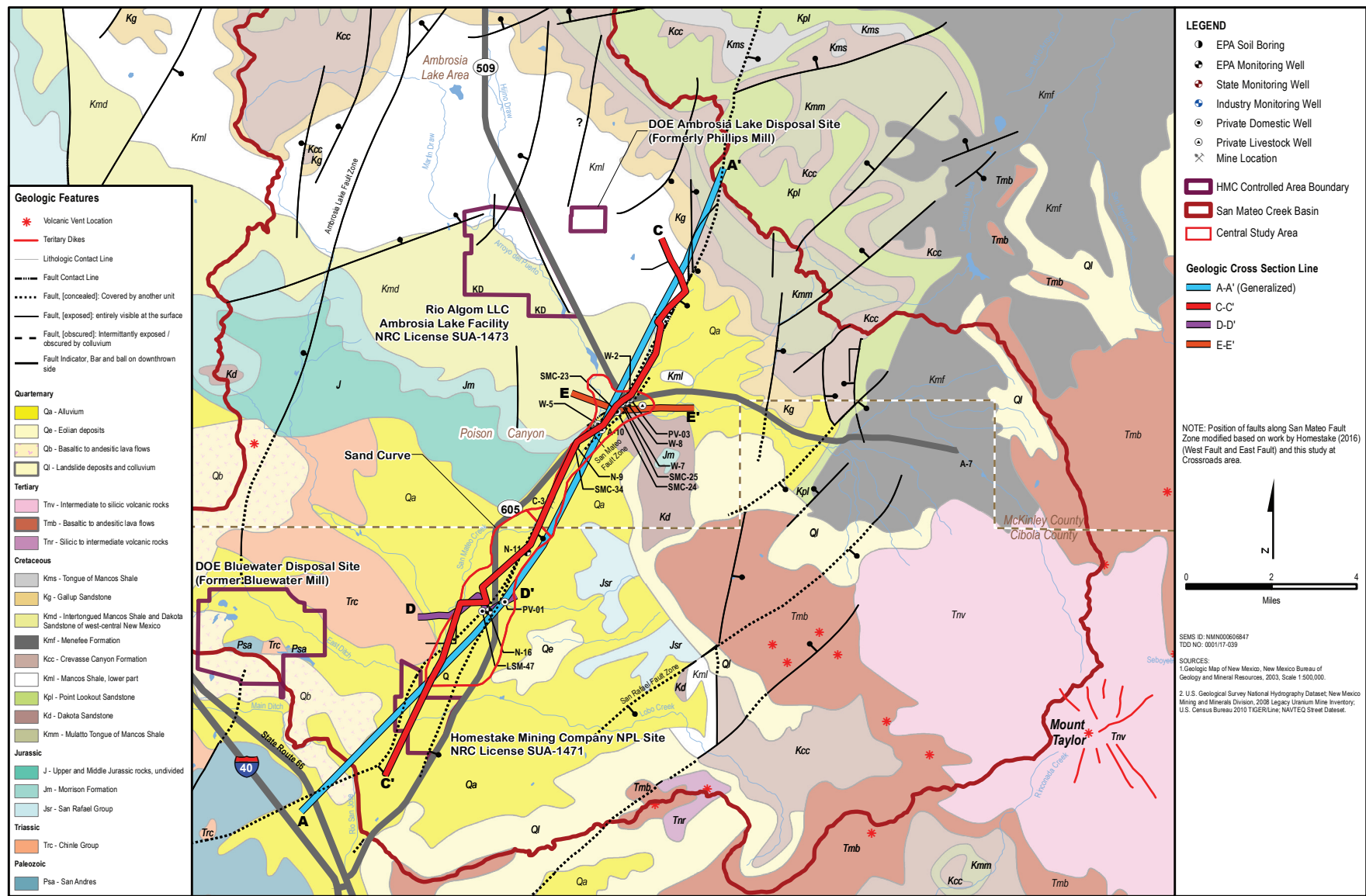
#### LEGEND

- Mine Location
- Uranium Deposit
- County Boundary Line
- Study Area
- HMC Controlled Area Boundary
- Navajo Nation Tribal Land
- U.S. Forest Service Land
- Estimated Boundary of Saturated Alluvium (2015-2018)



**Figure 2-3. Site Location Map - Mines**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

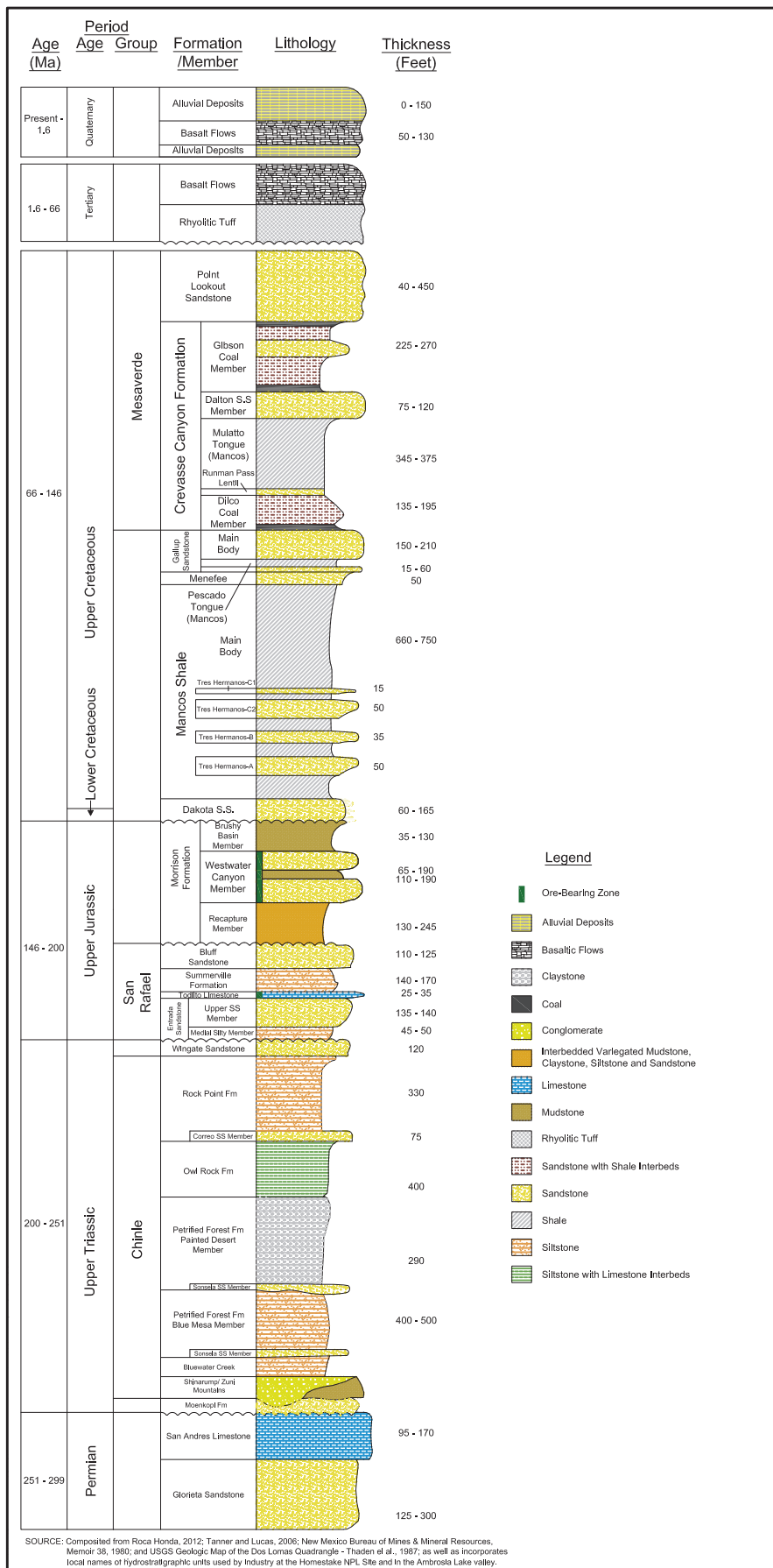
**Jacobs**



Source: EPA, 2018

**Figure 2-4. Regional Geologic Map**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

**Jacobs**



**Figure 2-5. Stratigraphic Column**  
San Mateo Creek Basin Groundwater Site:  
Central Study Area  
Cibola and McKinley Counties, New Mexico

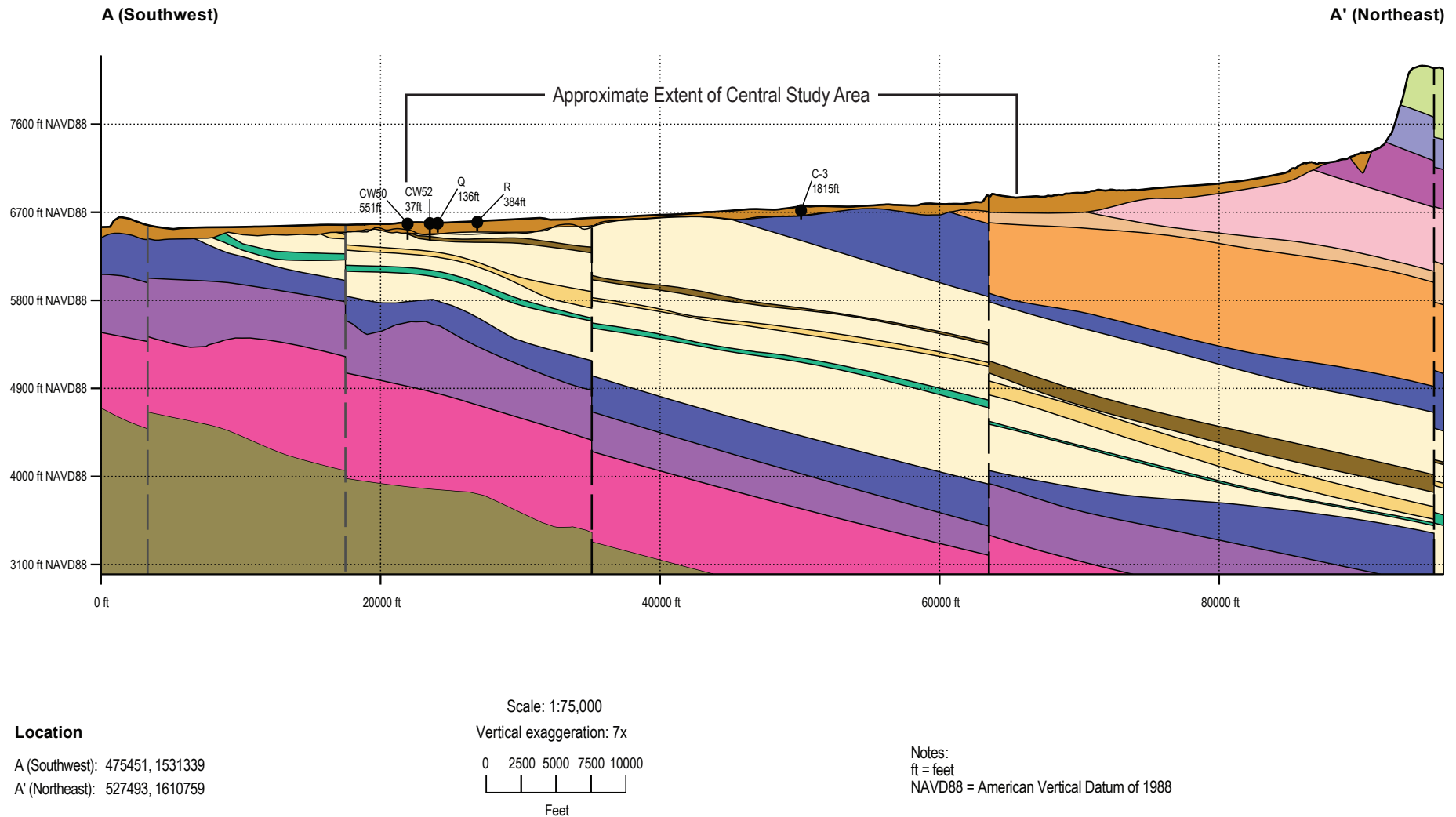
SOURCE: Composited from Roca Honda, 2012; Tanner and Lucas, 2006; New Mexico Bureau of Mines & Mineral Resources, Memoir 38, 1980; and USGS Geologic Map of the Dos Lomas Quadrangle - Thaiden et al., 1987, as well as incorporates local names of hydrostratigraphic units used by industry at the Homestake NPL Site and in the Ambrosia Lake valley.

Source: EPA, 2018

PPS0420200813ABQ

**Jacobs**





**Figure 2-7. Cross Section A-A' – Leapfrog™ Model**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

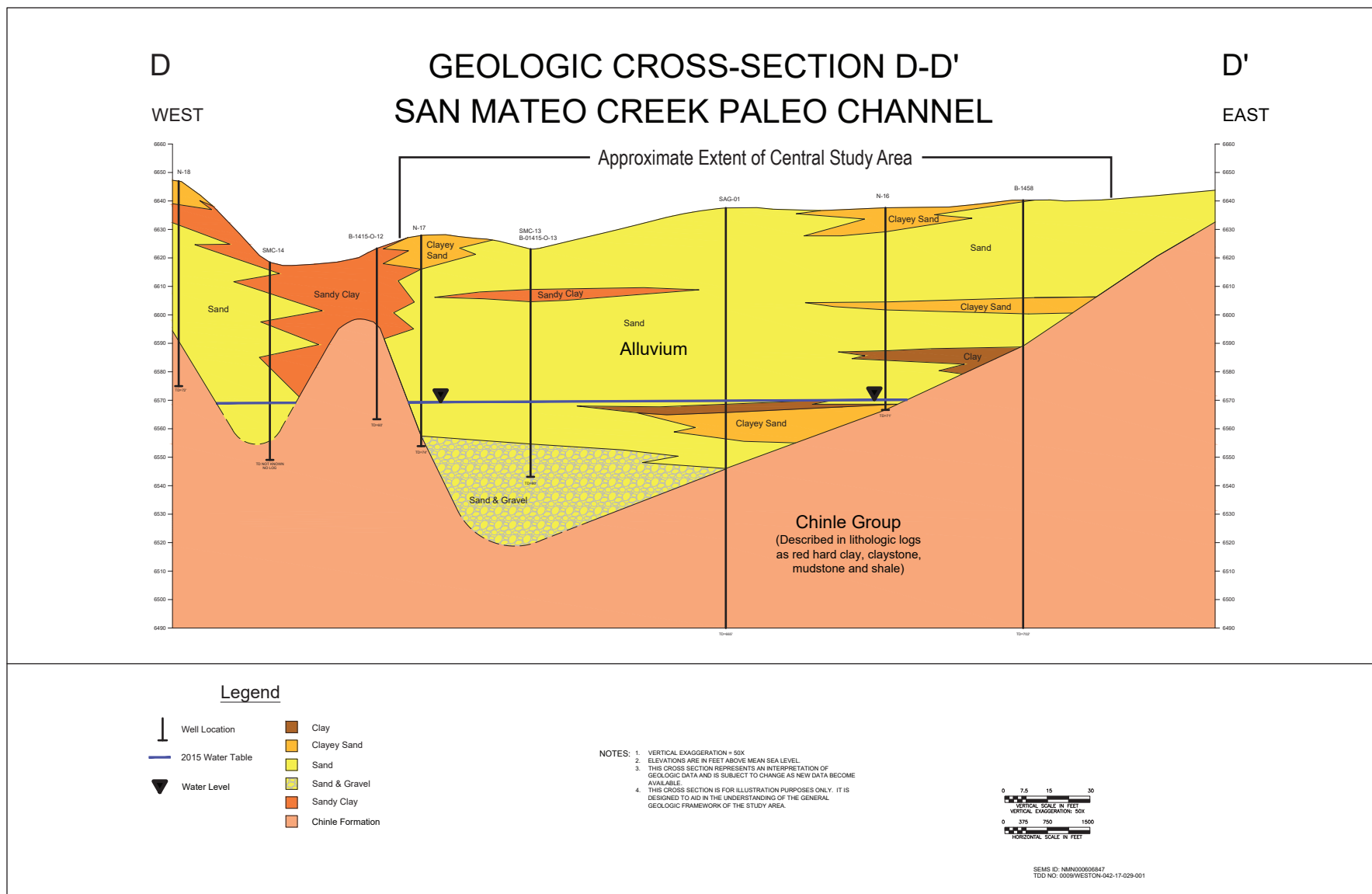
**LEGEND**

**Lithology**

|            |                |              |               |                 |                    |
|------------|----------------|--------------|---------------|-----------------|--------------------|
| Alluvium   | Chinle Shale 1 | Gallup       | Middle Chinle | Crevasse Canyon | Updated West Fault |
| Dakota     | Chinle Shale 2 | Glorieta     | San Andres    | Mulatto Tongue  | Updated East Fault |
| Morrison   | Chinle Shale 3 | Lower Chinle | Upper Chinle  | Precambrian     |                    |
| San Rafael | Chinle Shale 4 | Mancos       | Yeso          |                 |                    |

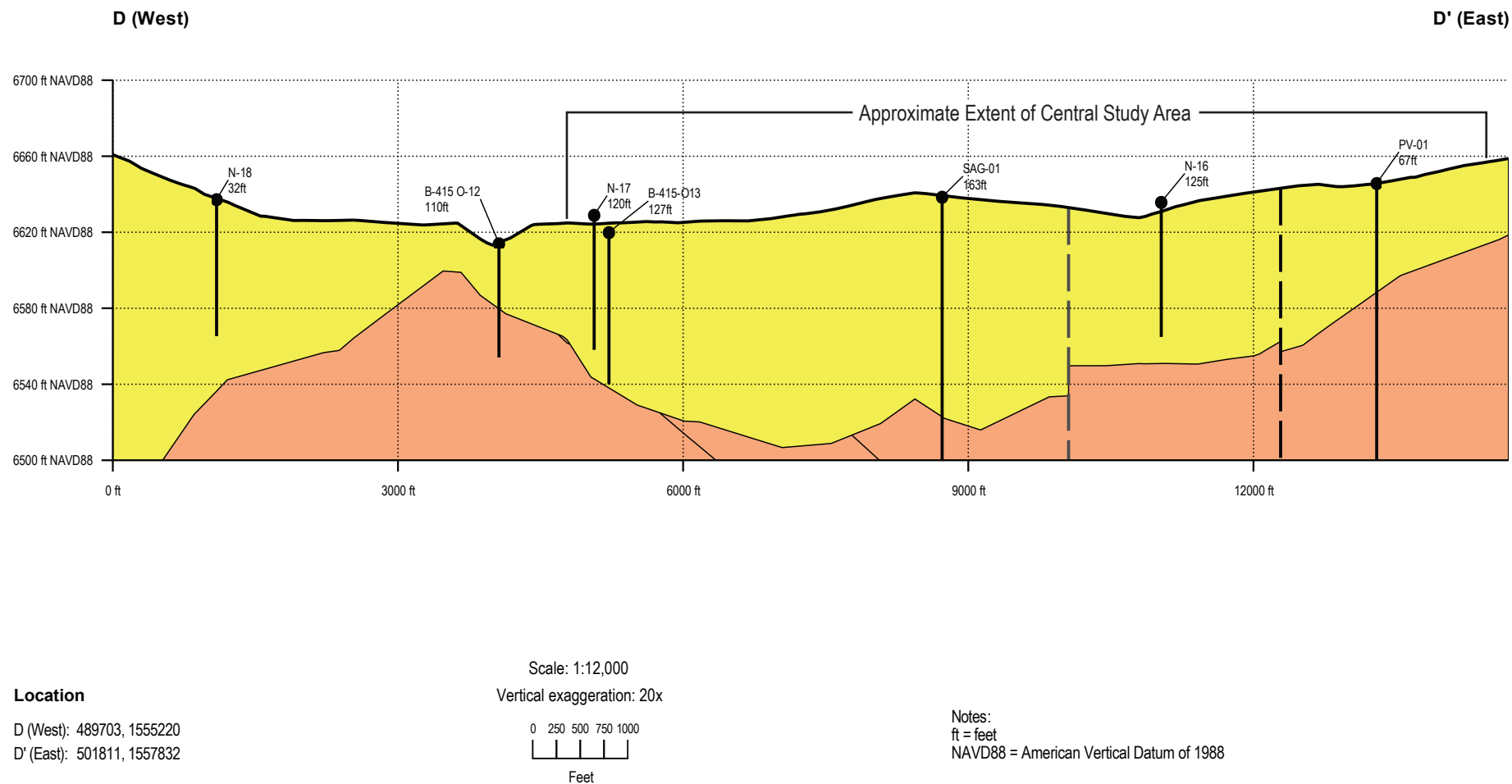
PPS0420200813ABQ

**Jacobs**



Source: EPA, 2018

**Figure 2-8. Cross Section D-D'**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico



## LEGEND

### Lithology

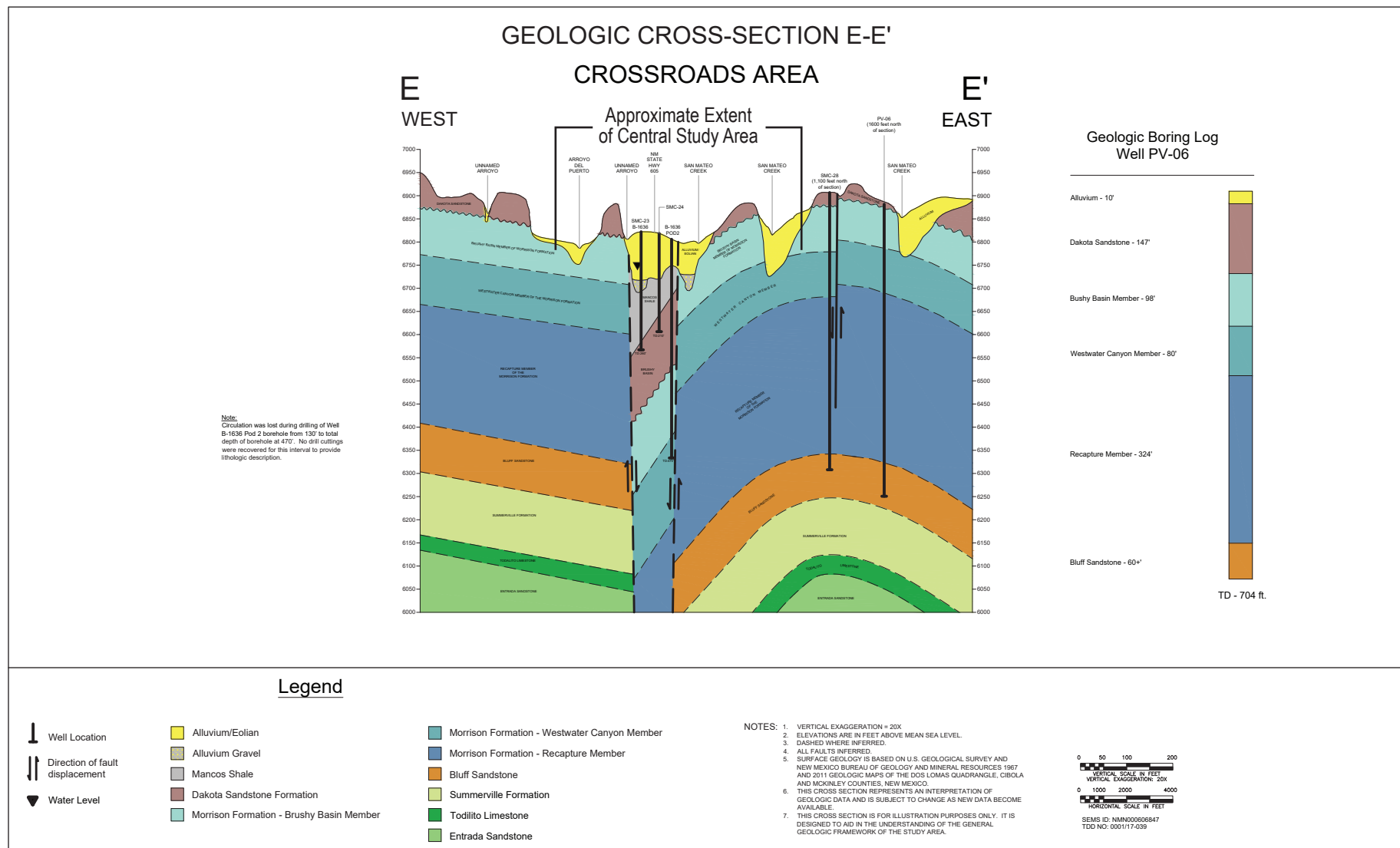
- Alluvium
- Chinle Shale 1
- Chinle Shale 2
- Upper Chinle

- Updated West Fault
- Updated East Fault

PPS0420200813ABQ

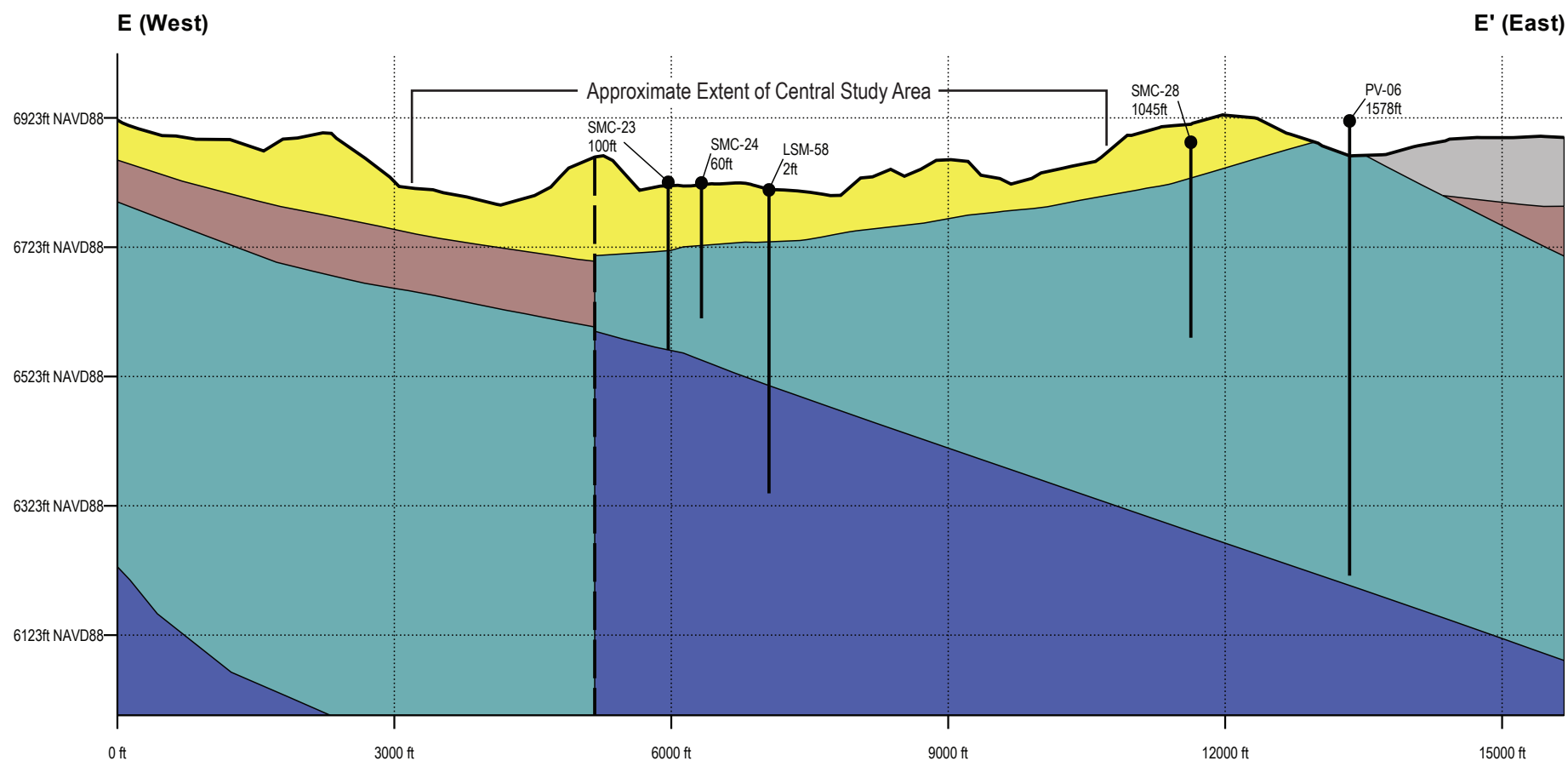
**Figure 2-9. Cross Section D-D' – Leapfrog™ Model**  
 San Mateo Creek Basin Groundwater Site: Central Study Area  
 Cibola and McKinley Counties, New Mexico

**Jacobs**



Source: EPA, 2018

**Figure 2-10. Cross-Section E-E'**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico



Scale: 1:15,000  
Vertical exaggeration: 7x

0 250 500 750 1000  
Feet

#### Location

E (West): 508706, 1582980

E' (East): 523878, 1581132

Notes:  
ft = feet  
NAVD88 = American Vertical Datum of 1988

#### LEGEND

##### Lithology

Alluvium  
Dakota  
Morrison

San Rafael  
Mancos

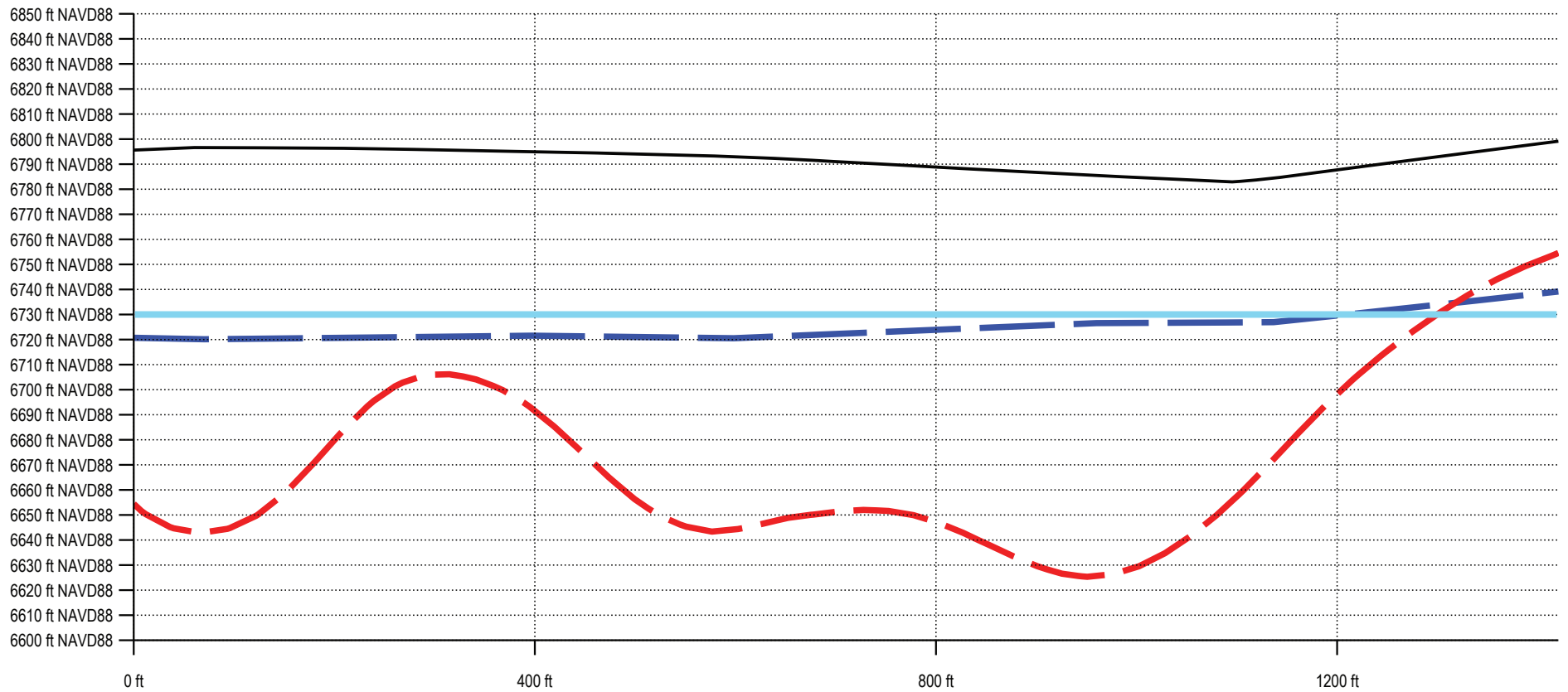
— Updated East Fault

**Figure 2-11. Cross Section E-E' – Leapfrog™ Model**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

**Jacobs**

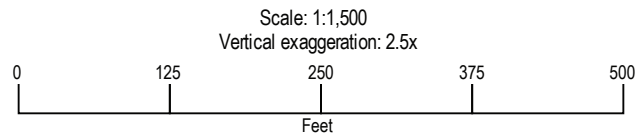
(Northwest)

(Southeast)



**Location**

(Northwest): 512906, 1580296  
(Southeast): 513839, 1579229



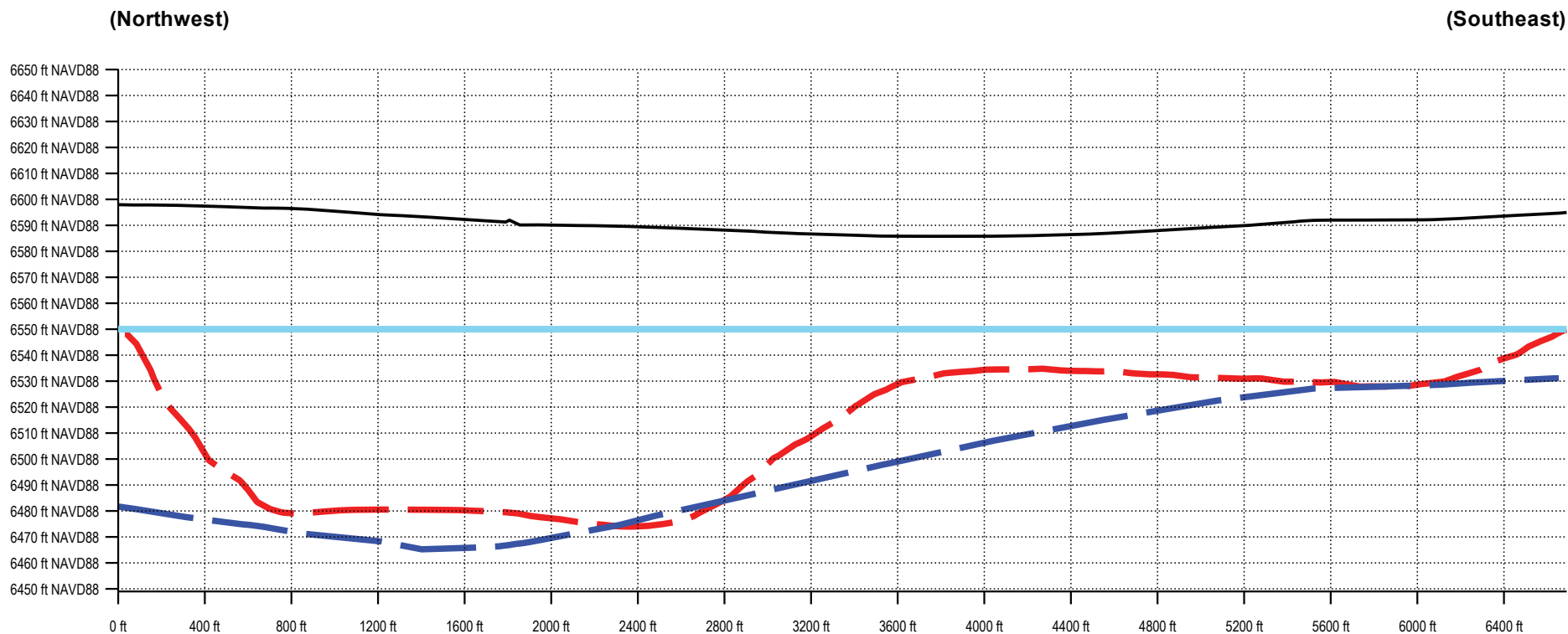
Notes:  
ft = feet  
NAVD88 = North American Vertical Datum of 1988

**LEGEND**

- Topography
- Leapfrog - Base of Alluvium
- EPA - Base of Alluvium
- Current Alluvial Aquifer Groundwater Elevation

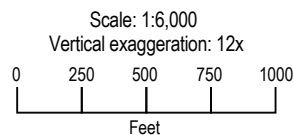
**Figure 2-12. Inferred Alluvium Base Comparison - Upper CSA**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

**Jacobs**



#### Location

6,550-A (Northwest): 491042, 1549781  
 6,550-A' (Southeast): 496032, 1545570



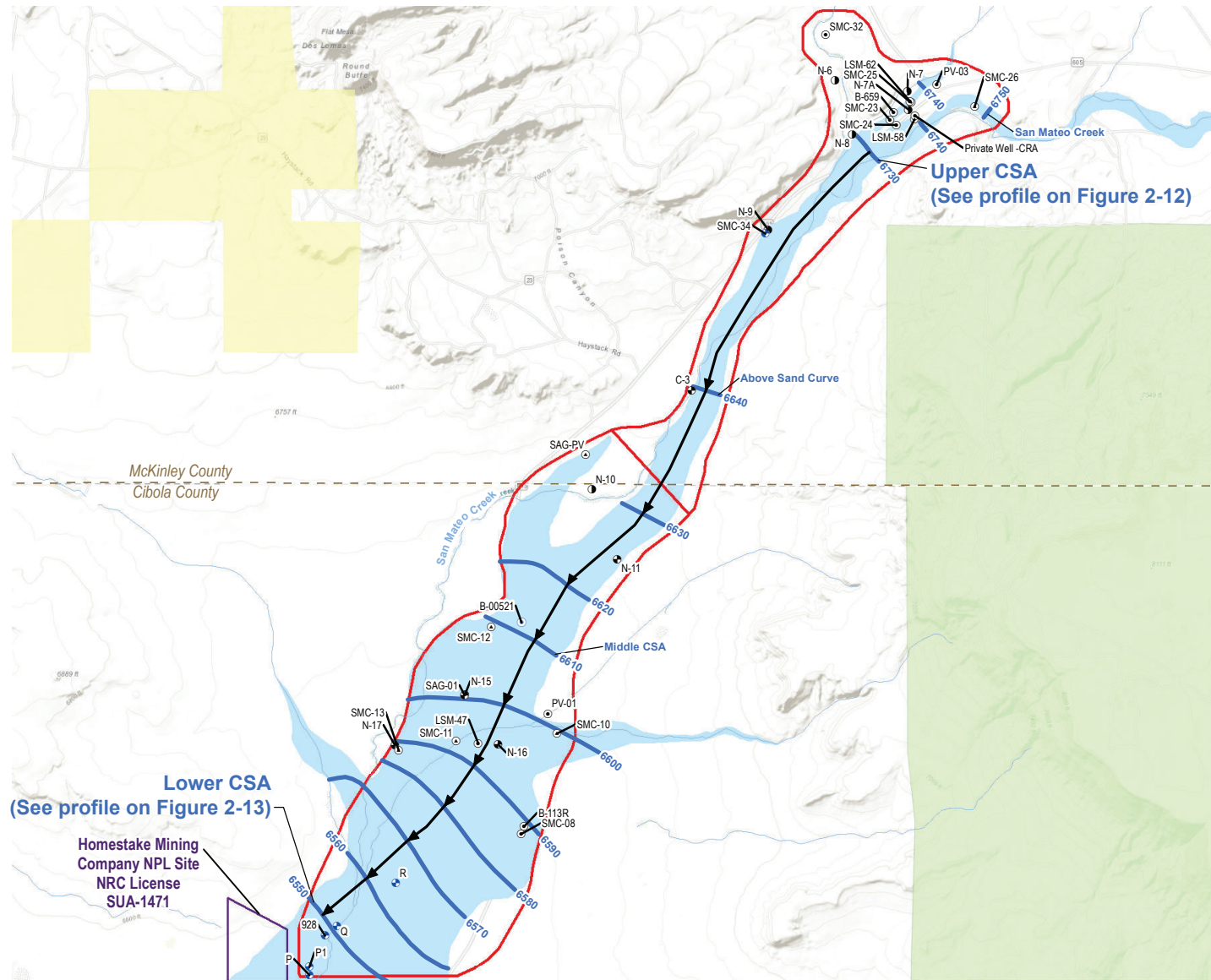
Notes:  
 ft = feet  
 NAVD88 = North American Vertical Datum of 1988

#### LEGEND

- Topography
- EPA - Base Of Alluvium
- Leapfrog - Base of Alluvium
- Current Alluvial Aquifer Groundwater Elevation

**Figure 2-13. Inferred Alluvium Base Comparison - Lower CSA**  
 San Mateo Creek Basin Groundwater Site: Central Study Area  
 Cibola and McKinley Counties, New Mexico

**Jacobs**



VICINITY MAP



0 4,000 8,000  
Approximate scale in feet

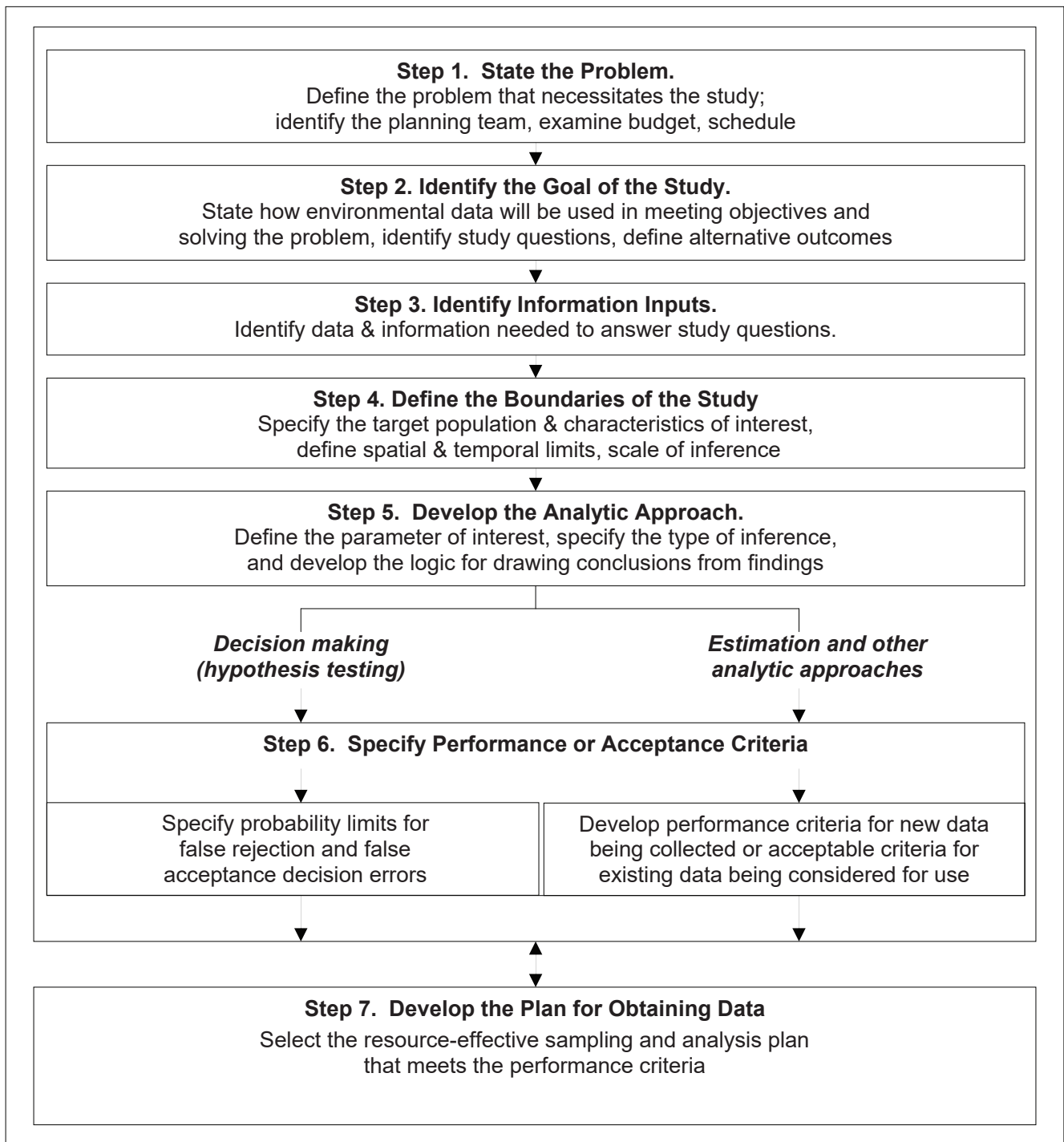
# LEGEND

- EPA Dry Borehole
- ⊕ EPA Monitoring Well
- ⊕ Industry Monitor Well
- ⊙ Private Domestic Well
- ⊙ Private Livestock Well
- ⊙ Private Well
- Surface Water Line
- County Boundary Line
- ➔ Inferred Groundwater Flowpath
- Groundwater Elevation Contour in Feet
- ▭ Study Area
- ▭ HMC Controlled Area Boundary

- Navajo Nation Tribal Land
- U.S. Forest Service Land
- Estimated Boundary of Saturated Alluvium (2015-2018)

Figure 2-14. Alluvial Ground Water Elevation Map 2015 (EPA 2018) and Alluvial Profile Locations  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

Jacobs



**Figure 4-1. The Data Quality Objective Process (from EPA, 2006).**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

**Appendix A**  
**Cultural Awareness and Protection Plan**

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## **1. Introduction**

This Cultural Awareness and Protection Plan has been prepared to support field investigation activities across the San Mateo Creek Basin (SMCB) Central Study Area (CSA). The CSA is an approximately 8-square-mile area (Figure 1-1 and Figure 1-2) that encompasses a portion of saturated alluvial sediments and bedrock within Cibola and McKinley Counties, New Mexico. The Remedial Investigation/Feasibility Study (RI/FS) will be performed under an Administrative Settlement Agreement and Order on Consent (Settlement) between the U.S. Environmental Protection Agency (EPA) and the Working Group (EPA, 2019). The RI/FS will be performed in accordance with the requirements of the Settlement (EPA, 2019) and Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (EPA, 1988).

This plan, written to comply with Section 106 of the National Historic Preservation Act of 1966, identifies the tasks involved in developing and implementing cultural resource awareness and protection for project implementation (EPA, 2013). Section 106 applies to projects where federal approval is required and/or are located on federal land. Measures that preserve and protect cultural resources will be implemented during the RI/FS. These measures include conducting a cultural resource investigation to document the existence of cultural resources that could be impacted by the implementation of this RI/FS and mitigating actions that protect and preserve findings or artifacts with historic or cultural significance.

### **1.1 Cultural Resource Investigation**

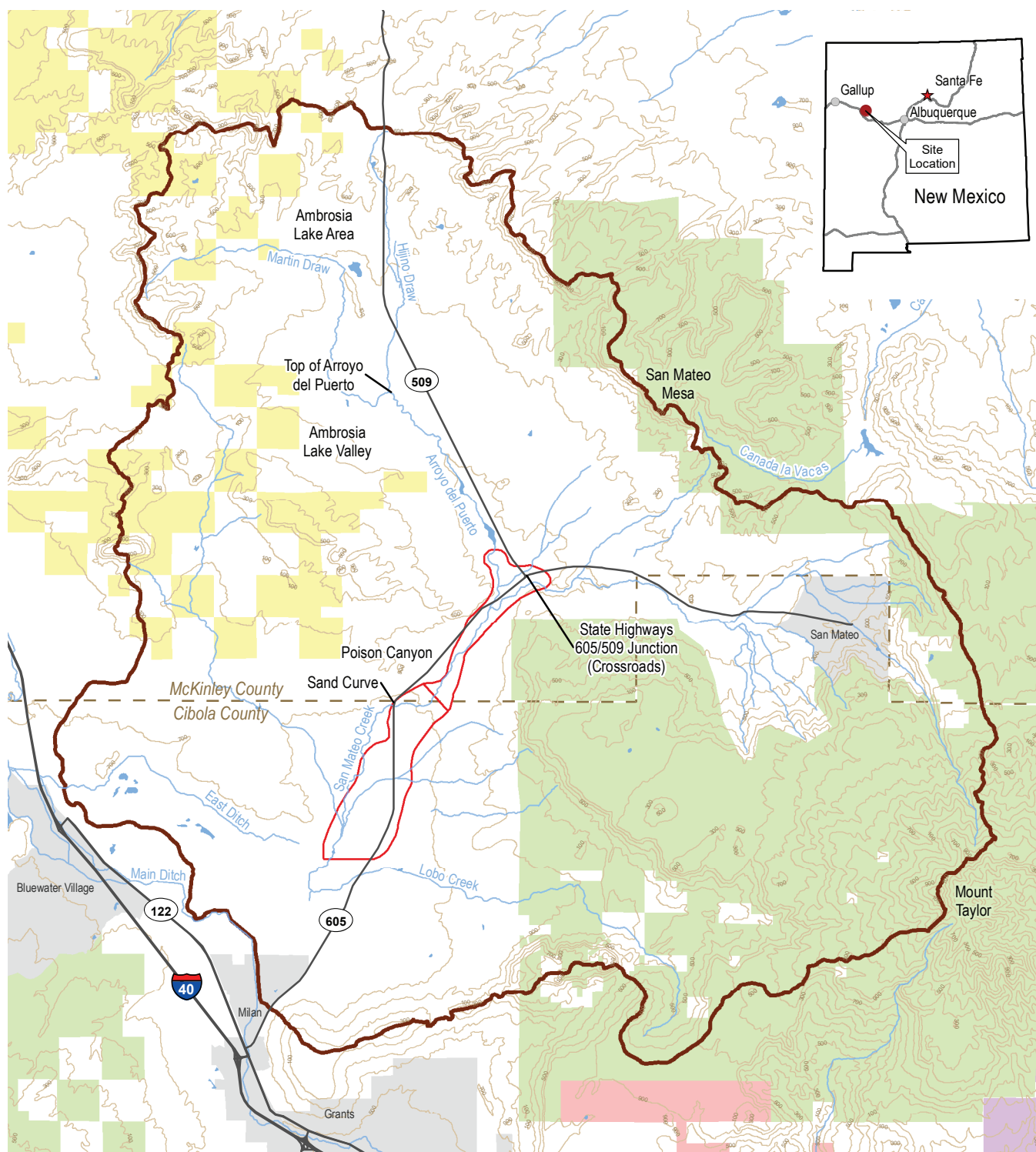
Once the RI/FS field investigation locations are confirmed, and prior to conducting field work, a cultural resource investigation will be conducted via a specialty contractor in coordination with federal regulatory, federal and state historic preservation, and tribal agencies (as appropriate). As described below, the cultural resource analysis consists of four key steps. Jacobs will complete these steps, if mandated by EPA or landowners, and will institute procedures to occur during field work to maximize cultural resource preservation and protection. Coordination and consultation are also anticipated between the public and state and federal landowners including the State of New Mexico and the U.S. Bureau of Land Management (BLM).

#### **1.2 Step 1: Initiate Review**

Federal approval of this project is required, and portions of the project will be located on federal and State-owned land, thereby creating the need for an initial review of the potential for cultural resource impacts. During this step, planning for an in-depth review and engagement with the New Mexico Historic Preservation Division, tribal organizations, agencies, and the public will occur.

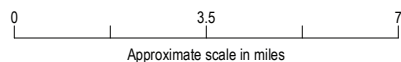
#### **1.3 Step 2: Describe and Collect Information on Field Activities and Areas of Historic or Cultural Significance**

Once the process has been initiated, data and information collection will occur to understand the scope of the RI/FS field work to be undertaken and the significance of historic and cultural resources within the CSA work areas.



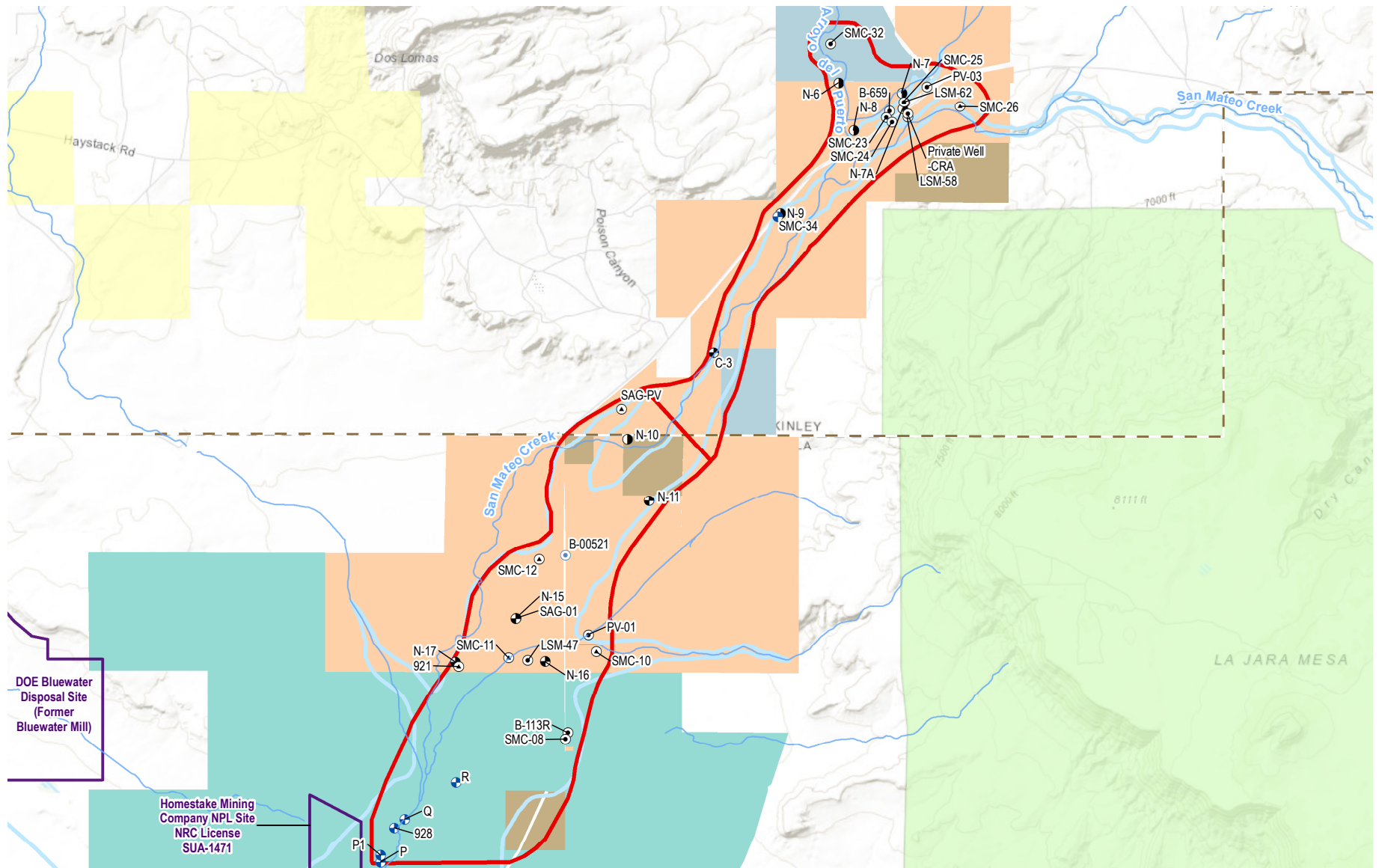
# LEGEND

- Elevation Contour (Feet)
- Central Study Area
- San Mateo Creek Basin
- Acoma Pueblo
- Laguna Pueblo
- Navajo Nation Tribal Land
- U.S. Forest Service Land
- Municipal Land



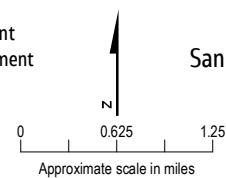
**Figure 1-1. General Location Map**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

**Jacobs**



# LEGEND

- EPA Dry Borehole
- ⊕ EPA Monitoring Well
- ⊕ Industry Monitor Well
- ⊕ Private Domestic Well
- ⊕ Private Livestock Well
- ⊕ Private Well
- Surface Water Line
- County Boundary Line
- Study Area
- HMC Controlled Area Boundary
- Navajo Nation Tribal Land
- U.S. Forest Service Land
- Private Land
- Homestake Mining of California
- State Land
- United States Government Bureau of Land Management
- Estimated Boundary of Saturated Alluvium (2015-2018)



**Figure 1-2. Site Location Map**  
San Mateo Creek Basin Groundwater Site: Central Study Area  
Cibola and McKinley Counties, New Mexico

**Jacobs**

### **1.3.1 Potential Impacts to CSA Work Areas**

This analysis will involve determining whether RI/FS work activities have the potential to cause effect. This activity includes providing a detailed description of field work including process, timing, number of personnel, and actions. It is anticipated that the RI/FS field work will include Jacobs and other contractor and subcontractor personnel conducting geophysical transects, drilling and monitoring well installation, aquifer testing, and groundwater sampling at selected locations across a roughly 20-square-mile area in the CSA.

Publicly and privately owned land will be accessed to complete the RI/FS field work. Teams will be riding on all-terrain vehicles and using support trucks, hauling trucks for equipment and supplies, drilling rigs, and support equipment such as pumps, tanks, and electrical generators to complete the RI/FS field work. The land is largely undeveloped and used for cattle ranching.

Jacobs will follow both the Section 106 requirements and the BLM and State of New Mexico processes when obtaining access, prior to conducting field work, and as the work is performed.

### **1.3.2 Identify Historic Properties and Areas of Historic and Cultural Significance**

This identification will determine whether properties or buildings are listed or eligible for listing in the National Register of Historic Places and identify areas of cultural significance. When assessing cultural significance, numerous elements are assessed including age, location in an archeologically sensitive area, and areas where traditional cultural people or properties were or are located or where significant events occur.

As part of the historic property determination, consultation will be made with the State Historic Preservation Office, the New Mexico Historic Preservation Division, Tribal Historic Property Officer (if applicable), local municipality, members of the public, and others. If a given work location within the CSA site does not have historic or cultural areas of significance, no further action is necessary, and documentation indicating that cultural resources are not at risk from activities at the location will be provided. If the work location area does include areas of historic or cultural significance, an assessment of the impacts will be conducted, and work locations may need to be modified.

## **1.4 Step 3: Assess Potential Impacts to Cultural Resources and Document Findings**

Informed by the nature and extent of RI/FS field activities and confirmation that cultural resources exist in the CSA, the next step will be to determine the potential for adverse effects. This would occur when an action carried out in the field directly or indirectly alters any characteristic (now or in the future) of a historic property that qualifies it for inclusion in the National Register. If it is determined that there is the potential for an adverse effect, measures that avoid, minimize, and mitigate the effects will be developed and implemented during the RI/FS.

## **1.5 Step 4: Address and Resolve Adverse Effects**

In coordination with stakeholders, impact mitigation actions will be described in detail as part of the cultural resource investigation findings. These actions will be taken to avoid, minimize, or mitigate effects by field team personnel prior to and during implementation of field work. These may include, for instance, modifying work processes or realigning geophysical transects to avoid the cultural resource(s).

These actions will include protocols for field personnel to address the unanticipated discovery of cultural materials. Training in these procedures and the required notifications will occur prior to field work commencing and will be completed by all team members who will perform field work. The training, procedures, and notification processes will be defined in the cultural resource investigation findings and implemented during the RI/FS field work.

## 2. References

- U.S. Environmental Protection Agency (EPA). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Office of Emergency and Remedial Response. October.
- U.S. Environmental Protection Agency (EPA). 2013. Cultural Resources Management. Retrieved from: <https://www.epa.gov/sites/production/files/2015-08/documents/r1-nhpa-cultural-resources-manual.pdf>
- U.S. Environmental Protection Agency (EPA). 2019. Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study. U.S. Environmental Protection Agency CERCLA Docket No. 06-01-20.

**Appendix B**  
**Data Management Plan**

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- B-7 Quality Control Review
- B-8 Data Reporting
- B-9 Data Corrective Action

**Table**

- B-1 Team Roles and Responsibilities

**Acronyms and Abbreviations**

|        |  |
|--------|--|
| ALS    | application level security               |
| CLP    | Contract Laboratory Program              |
| COC    | chain of custody                         |
| CRL    | Central Regional Laboratory              |
| CSA    | Central Study Area                       |
| DBA    | database administrator                   |
| DM     | data manager                             |
| DML    | database management lead                 |
| DMP    | data management plan                     |
| DQM    | data qualification module                |
| DV     | data validator                           |
| EDD    | electronic data deliverable              |
| EDP    | electronic data processor                |
| EPA    | U.S. Environmental Protection Agency     |
| EQEDD  | EQuIS electronic data deliverable        |
| FQM    | field quality manager                    |
| FTL    | field team lead                          |
| GIS    | geographic information system            |
| ID     | identifier                               |
| IDW    | investigation-derived waste              |
| Jacobs | Jacobs Engineering Group Inc.            |
| LIMS   | Laboratory Information Management System |
| NAD83  | North American Datum of 1983             |
| NMED   | New Mexico Environment Department        |
| PC     | project chemist                          |
| PDF    | portable document format                 |
| PM     | project manager                          |
| POC    | point of contact                         |
| QAPP   | Quality Assurance Project Plan           |
| QC     | quality control                          |
| RVF    | reference value file                     |
| SAS    | special analytical service               |
| SMCB   | San Mateo Creek Basin                    |
| SPM    | sample planning module                   |
| UTM    | Universal Transverse Mercator            |

# 1. Introduction

This data management plan (DMP) describes the data workflow process to be used on the San Mateo Creek Basin (SMCB) Groundwater Site – Central Study Area (CSA) Remedial Investigation/Feasibility Study project, using the EQuIS (EarthSoft, Inc.) corporate standard. The data workflow process includes the procedures and systems used to manage project-generated data from planning through reporting and, as necessary, data corrective action. The workflow processes and procedures are supplemented by best practice information. This DMP may be revised or amended to accommodate changes in the project scope and to better achieve project objectives.

## 1.1 Roles and Responsibilities

The responsibility for implementing the DMP is assumed by the project team, which includes the database team and the chemistry team. These teams have the defined roles listed below and shown on the organizational chart (Figure B-1). Table B-1 summarizes the specific minimum responsibilities for each role throughout the data workflow process. Roles may be combined under one individual or transferred across various roles as needed to achieve project objectives.

- Project Team
  - Project manager (PM)
  - Field team lead (FTL)
  - Field quality manager (FQM)
  - Field sample manager
- Database Team
  - Database management lead (DML)
  - Data manager (DM)
  - EPA database administrator (DBA)
- Chemistry Team
  - Project chemist (PC)
  - Data validator (DV)
  - US. Environmental Protection Agency (EPA) Analytical Point of Contact (POC)
- Client Team
  - Working Group project coordinator
  - EPA Lab Contact

Table B-1. Team Roles and Responsibilities

| Roles               | Responsibilities  |
|---------------------|---|
| <b>Project Team</b> |   |
| Project Manager     | <ul style="list-style-type: none"> <li>• Overall project responsibility.</li> <li>• Coordinates with team.</li> <li>• Adjusts the project-specific DMP as needed, with assistance from the DML.</li> <li>• Interacts regularly between teams and coordinates data transfers/downloads.</li> <li>• Defines data reporting needs and works across teams to assure Enterprise reporting dashboards meet project requirements.</li> <li>• Notifies data corrective actions POC (PC) when field or laboratory data errors are identified and communicates with database/chemistry teams and FTL to develop resolutions.</li> <li>• Follows up with appropriate team members to assure that data error resolutions are implemented in the Jacobs Engineering Group Inc. (Jacobs) EQuIS database and in associated work products such as manual log books, field forms, boring logs, well construction logs, data logger files, charts, report tables, data exports, etc.</li> </ul> |

| Roles                    | Responsibilities   |
|--------------------------|--|
| Field Team Lead          | <ul style="list-style-type: none"> <li>• Implements the project Quality Assurance Project Plan (QAPP) and project-specific DMP procedures.</li> <li>• Coordinates with teams during event planning.</li> <li>• Cascades messages to the field team.</li> <li>• Oversees/performs data generation events.</li> <li>• Oversees/prepares manual field data electronic data deliverables (EDDs) from field logbooks and field forms (field parameters, water levels, boring log observations, well construction information, etc.).</li> <li>• Performs quality control (QC) review of manual field data EDDs against source documents before sending to DM for loading.</li> </ul>  |
| Field Quality Manager    | <ul style="list-style-type: none"> <li>• Reviews field data against project plans.</li> <li>• Implements field data error resolutions to work products where applicable (manual logbooks, field forms, boring logs, well construction logs, Scribe data files, etc.).</li> <li>• Verifies that the field EDD is submitted to the DM.</li> <li>• Obtains field coordinate information from the field team and submits it to the geographic information system (GIS) coordinator.</li> <li>• Verifies that the GIS coordinator submits the sample coordinates to the DM in project-specific (latitude/longitude, state plane) and Universal Transverse Mercator (UTM) North American Datum of 1983 (NAD83) meter coordinates.</li> </ul> |
| Field Sample Manager     | <ul style="list-style-type: none"> <li>• Performs data entry and QC of field sample data into EQUIS.</li> <li>• Coordinates field sample data loading with DM.</li> <li>• Notifies data corrective actions POC (DM) when field data errors are identified and communicate with database/chemistry teams and PM to develop resolutions.</li> </ul>  |
| <b>Database Team</b>     |  |
| Database Management Lead | <ul style="list-style-type: none"> <li>• Develops and maintains the project database and data management process.</li> <li>• Coordinates project database structural and feature changes with the database provider, when needed.</li> <li>• Provides senior data management support to DM.</li> <li>• Sets up Enterprise dashboards for project teams.</li> <li>• Communicates with project/chemistry teams and DM to develop data error resolutions.</li> </ul>  |
| Data Manager             | <ul style="list-style-type: none"> <li>• Coordinates with PM, PC, and DML.</li> <li>• Sets up event in the sample planning module (SPM).</li> <li>• Loads EDDs to Jacobs EQUIS database.</li> <li>• Tracks completeness of event data via SPM.</li> <li>• Performs post-validation QC checks to assure data are ready to report.</li> <li>• Communicates with project/chemistry teams and DML to develop data error resolutions.</li> <li>• Implements corrective actions to the Jacobs EQUIS database and regenerates associated work products when directed by project team.</li> </ul>  |
| Database Administrator   | <ul style="list-style-type: none"> <li>• Maintains the EPA data management system.</li> <li>• Receives final EDD from DM.</li> <li>• Provides feedback on final EDD quality review.</li> </ul>   |

| Roles                           | Responsibilities  |
|---------------------------------|---|
| <b>Chemistry Team</b>           |   |
| Project Chemist                 | <ul style="list-style-type: none"> <li>Oversees data validation and project chemistry processes.</li> <li>Serves as POC between project team and laboratories.</li> <li>Assures data quality measures are met as specified in the QAPP.</li> <li>Reviews preliminary laboratory data for issues or unexpected results.</li> <li>Assures laboratory delivers compliant EDDs for database loading.</li> <li>Serves as POC for data corrective actions.</li> <li>Receives data error notifications and develops resolutions with project/database teams and DV.</li> <li>Implements corrective actions to chemistry work products where applicable.</li> </ul> |
| Data Validator                  | <ul style="list-style-type: none"> <li>Performs data validation in the data qualification module (DQM) or enters manual validation information for upload to Jacobs EQuIS database by the DM.</li> <li>Schedules senior review of data validation.</li> <li>Notifies data corrective actions POC (PC) when validation data errors are identified and communicates with project/database teams and PC to develop resolutions.</li> <li>Implements corrective actions to data validation work products where applicable.</li> </ul>   |
| EPA Analytical Point of Contact | <ul style="list-style-type: none"> <li>Procures Contract Laboratory Program (CLP) and Central Regional Laboratory (CRL) services.</li> <li>Serves as POC between project team and CLP/CRL laboratories.</li> <li>Assigns CLP and/or special analytical services (SAS) numbers for samples.</li> <li>Submit EDDs.</li> <li>Orders EPA sample tags and CLP/SAS numbers from client.</li> </ul>  |
| <b>Client Team</b>              |   |
| EPA Lab Contact                 | <ul style="list-style-type: none"> <li>Adds, alters, and deletes users, roles, permissions, and sites in the EPA EQuIS database.</li> <li>Oversees Working Group EDD submissions to EPA.</li> <li>Adds approved valid values requests to EPA EQuIS database.</li> </ul>   |

## 1.2 Communication and Meetings

Consistent communication among project team members throughout project execution is essential for data management success. Communication should begin during the event planning phase of data workflow and continue through the data reporting phase. The following will facilitate communication among teams throughout the project:

- **Project Planning Meeting:** A work plan preparation meeting with the PC and DM to determine what data needs to be collected and from where, as well as laying the groundwork for how that data will be recorded, organized, uploaded, and reported in relation to the Jacobs EQuIS database for the SMCB CSA project (herein referred to as Jacobs EQuIS database).
- **Kickoff Meetings:** Having kickoff meetings (via teleconferences) before commencing field events to ensure that all planning aspects have been covered and that expectations for team member roles, project schedule, and project delivery are understood.
- **Project Email Distribution List:** Setting up and using an email distribution list to broadcast information among team members (for example, receipt of laboratory deliverables, status of data loading, status of data validation, delivery of data reports, data error notifications to the data corrective actions POC, etc.).
- **Regular Team Meetings:** Holding regular meetings among the three teams to provide updates and discuss issues as they develop.
- **Periodic meetings** will be scheduled with EPA, the New Mexico Environment Department (NMED), and the Mining and Minerals Division throughout the RI/FS at key points in the process as needed, including after each key deliverable, including the technical memoranda submitted after each phase of the RI.

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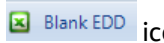
## 2. Database Management System

Jacobs has selected the EQuIS database system by EarthSoft, Inc., to manage environmental remediation and restoration site data collected for the SMCB CSA project. Details about user access, EDD formats, and valid values are described in the sections below.

### 2.1 EQuIS User Access

Jacobs uses the EQuIS Online cloud-based environmental data management system to manage client data. Requests for external user access can be made on a per-individual, per-facility basis to the DML, Kari MacGregor, at [Kari.MacGregor@jacobs.com](mailto:Kari.MacGregor@jacobs.com). Jacobs is using the application level security (ALS) model for EQuIS Professional (Pro) database access; therefore, an Enterprise user account with an applicable ALS connection string is required for Pro access.

### 2.2 Electronic Data Deliverable Format

Multiple EDD formats are available for loading data into the EQuIS database. For this project, Jacobs will use the EQuIS EDD (EQEDD) format. The EQEDD specifications and field descriptions can be exported from either Standalone electronic data processor (EDP) or Professional EDP by clicking the  icon on the home ribbon near the top of the user interface. Just above the  icon is the  icon, which exports a "load-ready" Microsoft Excel template that can be populated by field or laboratory teams to expedite data loading to EQuIS.

### 2.3 Valid Values

Valid values, the controlled vocabulary assigned to specific data fields in the EQuIS system, are maintained by Jacobs. Data fields requiring specific, controlled vocabulary are identified in the EQEDD format specification. The reference value file (RVF) for use with the Standalone EDP are provided upon request.

### 3. Data Workflow

Data workflow describes the process of managing data from the planning stages through reporting. The main phases of the data workflow are as follows (in approximate sequential order):

- Event planning
- Data generation event
- Data tracking
- Data entry and QC
- Database loading
- Data validation
- QC review
- Data reporting
- Data corrective action

The data workflow chart (Figure B-2) shows an overview of the procedures and software components that support the main phases of the data workflow; details are summarized in the sections below.

#### 3.1 Event Planning

The first phase in the data workflow is event planning (Figure B-3). This phase involves determining what data need to be collected and from where and identifying how that data will be recorded, organized, uploaded, and reported in relation to the Jacobs EQuIS database.

Event planning begins with project planning. The project team works with the chemistry team and database team to develop event specifics in plans such as the work plan and the QAPP. During this phase, the following should be considered:

- Location Identifiers (IDs): Prevent duplication and maintain naming conventions by reviewing location IDs already in use before creating new IDs (check location IDs in an existing Jacobs EQuIS database and/or among historical data).
- Sample IDs (CLP/ SAS): CLP or SAS numbers will be assigned from the analytical POC. CLP numbers will be generated for EPA laboratories. SAS numbers will be generated for subcontract laboratories.
- Existing Project Coordinate System/Units: Assure that data are spatially relatable within a single, consistent coordinate system by checking for and matching historical or existing project coordinate systems and units (where appropriate) when planning additional spatial data collection. This includes checking the horizontal and vertical datums in use (such as NAD83). Note that translation of historical spatial data may be required if a different coordinate system or unit is required.
- Coordinates/Geospatial Features for Working Group EDD Submissions: Assure that location coordinates will be available for Working Group EDD submissions in both the UTM in meters and latitude/longitude in decimal degrees (both relative to the NAD83 datum). This can be accomplished by original request to surveyors or by translation by Jacobs GIS staff if UTM NAD83 in meters is not the designated project coordinate system, datum, and units. In addition, Jacobs GIS staff will be consulted on the preparation of site-specific geospatial features suitable for EDD submission to EPA. The geospatial features should be prepared in the coordinate system/datum of UTM NAD83 in meters.
- Laboratory EDD Capabilities: Assure that the laboratory's ability to accurately produce the EQEDD format by requesting and reviewing an example EDD (check data types, structure, valid values, relational integrity, correct/complete field population per sample, and result types).
- Laboratory Reporting Procedures: Establish laboratory reporting procedures by providing target analytical lists and reporting limits to the laboratory in advance. Nondetection defaults will be consistently stored in

the reporting detection limit field. This could include adjusted method detection limit and adjusted reporting limit, per the project-specific requirements.

- **Historical Data:** Assess the existence, quantity, availability, form/format, and usability of historical site data for possible inclusion in the Jacobs EQuIS database. See Section 3.1.2 for details.
- **Data Verification Levels:** Establish the levels for initial and escalated data verification checks of EDDs against source documents. See Section 3.4.3 for details.

Once the teams define the event, sample planning continues using the following approaches (shown on Figure B-3):

- **EQuIS SPM:** Several fields that must be populated before the data generation event include site information, analyses, sampler, laboratory list, and sampling. Once created, sample IDs, analyses, bottles, preservations, etc., can be assigned to samples IDs. Sample container labels can be printed out before sampling, requiring that only the sample date/time be handwritten.
- **Manual Sample Planning:** Consideration should be given to the field data entry approach needed to prepare and document sampling and field information. Field data can be recorded in log books, specific field data collection forms, electronic field forms, or any other method of documentation agreed upon by the project, database, and chemistry teams. Field form use and format will be captured in the project-specific DMP and/or project instructions. Once completed, field data can be manually transcribed into an EQEDD template.

### 3.1.1 Identifier Naming Conventions

Naming conventions for location and sample IDs will be developed and agreed upon by the project team, database team, and chemistry team during the event planning phase, if not already defined during previous events or specified by EPA. Consideration must be given for the location and sample types to meet the required character length for the sys\_loc\_code field in the dt\_location table of the Jacobs EQuIS database. Attachment B1, Identifier Naming Conventions, provides example naming conventions and the required database field lengths allowed for these IDs.

### 3.1.2 Historical Data

Special consideration will be given to historical data identified for loading to the Jacobs EQuIS database due to the often-limited nature of the historical data and the wide variety of the data sources, both of which can affect the approaches to data preparation and the level of effort required.

#### 3.1.2.1 Historical Data Inventory

An inventory of the available historical data will be taken, with special attention paid to the following aspects:

- **Data Form:** Determine whether any historical data are available in electronic files as opposed to paper hard copies. If electronic files are available, identify the file formats (such as portable document format [PDF] files, Microsoft Excel, Word, Access databases, SQL databases, etc.). PDF files should be examined for their method of generation (that is, scanned images or digitally generated content).
- **Data Format:** Assess the number and type of data formats that exist among the available historical data sources (for example, cross tabular tables commonly used for reports, tabular tables, database record exports, various EDD formats, laboratory Form 1s, etc.).
- **Data Usability:** Evaluate whether sufficient information is available in the historical data source to meet the requirements of an appropriate, loadable EDD format. The historical data should be examined for quality, which may lead to their exclusion from the Jacobs EQuIS database if found to be suspect or contain errors.
- **Data Duplication:** Assess whether there is overlap in the data reported among the historical data sources. Eliminating these overlaps can help reduce the likelihood of data duplication in the Jacobs EQuIS database.

### 3.1.2.2 Historical Location Identifiers

Existing location IDs should be tabulated from the data sources selected during the historical data inventory, then compared to location IDs already loaded into the Jacobs EQulS database. Duplication in IDs found, particularly those resulting from variations in naming conventions, should be eliminated so that only a single form of a location ID refers to a specific site location (for example, MW-1, MW-01, and MW1, all referring to the same location unified as MW-01). Location IDs not already in the Jacobs EQulS database should be loaded prior to the creation of new IDs during the event planning.

## 3.2 Data Generation Event

Once the event has been planned, workflow moves into the data generation event phase (Figure B-4). This phase is the actual production of data, including samples and data collected directly from the field, as well as analytical data generated by the laboratory. Figure B-4 lists the types of field data typically collected, along with what specific information must be included for the adequate collection of each.

The process of data capture in the field will be accomplished using the following approaches (shown on Figure B-4):

- **EQulS Collect:** Field sample information, including the sample date/time and notes and observations are typed into EQulS Collect and loaded directly into the EQulS database. Chain of custody (COC) documents can then be printed to accompany samples shipped to the laboratory.
- **Manual Data Collection (Field Data):** Data are recorded manually in field logbooks, field data collection forms, and/or electronic field forms for later entry and uploaded into EQulS Collect, EQEDD templates, and/or tools.

Capture of analytical data by the laboratory is accomplished primarily using a Laboratory Information Management System (LIMS) but may be supplemented using manual forms (such as sample weight record sheets or temperature readings). Regardless, all sample data and associated QC, matching data in the laboratory hard copy reports, should be available in an EDD format from the laboratory.

## 3.3 Data Tracking

The project and chemistry teams will be responsible for sample tracking. The tracking reports in EQulS SPM provide completeness checks.

## 3.4 Data Entry and QC

Data generated during the event requires entry into an EQEDD format that can be loaded directly to the Jacobs EQulS database. This process is the next phase in data workflow, data entry, and QC (Figure B-5).

### 3.4.1 New Data Entry

For newly generated field data, the level of data entry and the EDD processing required are dependent upon the approach selected for field data capture during the data generation phase:

- **EQulS Collect:** Field information, including the sample date/time and any notes or observations, will be recorded in EQulS Collect and uploaded directly into the database.
- **Manual EDD Field Data:** Data captured in field logbooks, field forms (such as groundwater forms, sediment boring logs, COCs), and electronic field forms must be manually entered or uploaded into an electronic EQEDD template by the FTL. Electronic logger data will require transformation into an EDD file format appropriate to the type of data collected (water levels logged in wells would typically be converted to the EDD WaterLevel\_v1 EDD file format).
- **CLP EDD:** Consists of one universal deliverable, which will require reformatting by the DM to create an EPA-compliant EQulS EDD.

- CRL EDD: Consists of two deliverables (SAMPDATA and QC DATA). This format will require reformatting by the DM to create an EPA-compliant EQulS EDD.
- EQEDD (subcontract) EDD: The PC will coordinate with the laboratory to provide an EPA-complaint EQulS EDD. This EDD will consist of three deliverables: laboratory sample, batch, laboratory test results with QC.
- Other EDD (different than manual): In cases where specialty or geotechnical laboratories do not have the capability to provide an EDD, the PC and DM will coordinate with the laboratory to establish data reporting procedures.

Laboratories are responsible for transforming newly generated analytical data from their LIMS to the EQEDD format provided during the event planning phase. In the instance where a laboratory is unable to produce the requested EQEDD format, an EDD file will need to be prepared from whatever data deliverable format is available from the laboratory. ***In either case, the DM must confirm that the reporting\_detection\_limit field in the TestResults\_v1 EDD file and/or TestResultsQC\_v1 EDD file is being populated with whichever limit the nondetects are being reported to by the laboratory (which can vary).*** This allows for consistent reporting of nondetect limits from EQulS Enterprise and EQulS Pro by referencing a single field.

### 3.4.2 Historical Data Entry

When legacy or historical data are identified for potential upload to the project database by project team members during the planning meeting, the PC will then evaluate the historical data for quality level and usability. If the PC determines that the historical data are usable and of sufficient quality to be used for data analysis, evaluation, and reporting, the PC will obtain approval from the PM to have the data uploaded to the project database. Once approved to upload, the PC will work with the project DML to identify an appropriate approach to migrate the historical data to the project database.

Historical data typically requires a combination of electronic data transformation and manual data entry to prepare a loadable EDD format (that is, EQ EDD or other EQulS-compatible format). When an electronic form of the source data is available (for example, SQL/Oracle data files, Microsoft Access or Excel files, text formatted files, digitally produced PDF files), data transition is more efficient and less prone to errors in data transfer over manual entry. If only hard copy reports or scanned images are available, fully manual data entry into an electronic EDD template may be required. In addition, depending on project needs, scanned hard copy files may be loaded to the Jacobs EQulS database as documents for subsequent electronic retrieval from the EQulS document management system.

The PC will work with the DM to identify limitations to the historical data set and qualify the data in such a way as to clearly capture these limitations in the project database. Any data limitations will be documented at the result level in the interpreted qualifier field and supplemented in the result remarks field as appropriate. Notes on limitations may also be captured at the analysis test and sample level using those remark fields.

### 3.4.3 Data Entry Quality Control Review

Review of prepared EDDs before loading is essential to data quality in the Jacobs EQulS database and reduces the likelihood of post-load data corrective actions. Figure B-5 details the QC review aspects required for both field and laboratory data that are newly generated and for historical data.

For data verification checks of EDDs against source documents, checks are initially performed at a 10 percent level when the data capture is fully electronic (for example, via laboratory LIMS or electronic data logger) by the PC as outlined in the project-specific QAPP. When data capture involves a manual entry step, such as manually entering data into electronic EDD templates after the event, the initial level of data verification may be as much as 100 percent, depending on the data quality objectives defined by the project team and the chemistry team during the event planning phase. The FQM performs QC of field-collected data as outlined in the project quality plan and/or project instructions. If errors are found during the initial verification checks, then the checks are escalated to a larger percentage of the data until an adequate level of quality has been confirmed (as prescribed by the project).

The final step in the QC review process is when the DM uses Standalone EDP to check EDDs electronically for compliance with their corresponding EDP format (EQEDD, EQuIS Data Gathering Engine, other) and with EPA valid values.

### 3.5 Database Loading

The database loading phase begins after the data entry and QC phases, once the prepared EDDs have passed the required QC review. Figure B-6 shows the process of loading EDDs to the Jacobs EQuIS database, using either Professional EDP or Enterprise EDP, and starts with the same EDP format checks as performed by Standalone EDP during the data entry and QC phases. However, EDD valid values are checked against those stored in the Jacobs EQuIS database rather than in an RVF with Standalone EDP. Once past the format and valid value checks, additional checks performed during the EDP create and commit steps of the loading process to confirm compliance with the database structure and the presence of existing records (applicable to certain data commit types). ***Note that location IDs must be present in the database prior to loading EDDs that reference those IDs (that is, location IDs must be loaded in advance of data referencing them).***

The following is a typical EDD loading order based on the EQuIS database structure (shown on Figure B-6):

- Location data
- Field data (location-based)
- Field data (sample-based)
- Laboratory data

### 3.6 Data Validation

Once the QC-reviewed data have been loaded to the Jacobs EQuIS database, the usability of the analytical data is defined during the data validation phase of the workflow. Data validation can be performed using either DQM or manually entering in qualifiers as shown on Figure B-6.

#### 3.6.1 Manual or External Automated Data Validation Entry

Data validation is performed manually using laboratory reports. Electronic data exported from the Jacobs EQuIS database using EQuIS Pro or EQuIS Enterprise is validated and then re-loaded back into the Jacobs EQuIS database using EDP and the "Update Only" commit type (Note: Enterprise EDP does not allow for the selection of commit type in the Enterprise EDP widget; therefore, contact the DML so a specific EDP format option can be set up in the Enterprise system configuration with the "Update Only" commit type for this purpose). Alternatively, the validation information may be manually entered into the laboratory EDD (that is, the laboratory-provided EDD in the EPA Region 5 EDD format) prior to data loading.

Attachment B2, Quality Control Review, provides details about the entry of validation information and examples.

#### 3.6.2 EQuIS DQM

Data validation is performed electronically and stored directly in the Jacobs EQuIS database. The workflow and operational processes for DQM are located online at <http://help.earthsoft.com/default.asp?W3029>.

### 3.7 QC Review

The QC review phase follows the data validation phase in the final preparation for data reporting. As shown on Figure B-7, this phase includes the QC review of manually validated data prior to loading updates to the Jacobs EQuIS database, and a QC review of any unvalidated data, the final validated data generated by the DQM, or data from an alternate, external automated validation tool (after automated review data updates are made to the Jacobs EQuIS database).

#### 3.7.1 Preliminary Data Reporting QC

Preliminary data reporting is an automated process. Once the EDD passes the automated EDP format specification checks, the preliminary data will be uploaded to the project database, which triggers the report

generation agent. Preliminary data reports generated will be qualified as unvalidated to document the status of data being reported, and no manual QC review will be performed prior to release to the project team. The project team should QC the sample ID numbers and cross-referenced sample names, sample date and time, and completeness (all analytes/samples reported), verify the units are consistent between the sample results and applicable screening values, and verify that all deliverables with preliminary data are clearly identified as unvalidated. The PM will qualify the data submittal email with the following language, "The data contained in the summary table is preliminary data. It is not validated, and the data and screening level comparison are subject to change pending completion of data validation." Tables generated will be stamped "Draft" on every page.

### **3.7.2 Prevalidation Preliminary Reporting QC**

The project team may request data tables prior to the completion of data validation. This prevalidated data must still undergo a QC review to assure proper reporting. Checks will be completed following the Pre-Reporting Quality Control section in Attachment B2, including the detect flag, reportable result, and reporting detection limit.

### **3.7.3 Manual Data Validation QC**

Because of the hand-entry involved in manual data validation, QC review of validated data by the DM prior to loading to the Jacobs EQulS database is essential. In addition, corrections are easier to make before loading the validated data than after the validated data is in the Jacobs EQulS database. Figure B-7 shows the fields requiring QC review, for which the manual data validation entry approach given in Attachment B2 can serve as a guideline.

### **3.7.4 Pre-Reporting QC**

Once any validated data have been loaded or updated to the Jacobs EQulS database, additional QC review checks are needed to confirm that the auto-validated and unvalidated data (such as waste characterization analysis or other sample delivery groups that do not require validation based on project-specific procedures) in the Jacobs EQulS database are ready to report. These checks should be performed as a final step prior to preparing table reports, figures, regulatory submissions, etc., as discussed in Section 3.8. Figure B-7 lists these essential checks, and Attachment B2 provides greater detail.

## **3.8 Data Reporting**

The data reporting phase illustrated on Figure B-8 begins after the completion of the QC review phase and data are considered final in the Jacobs EQulS database. In the data reporting phase, data can be reported, exported, or transformed through either EQulS Enterprise or EQulS Pro to meet data analysis and reporting needs. As suggested by Figure B-8, the variety of reporting possible through EQulS Enterprise and EQulS Pro is extensive. However, reporting varies greatly and is often project-driven. For this reason, reporting is not detailed in this DMP, although specifics on many EQulS reports can be found online at <http://help.earthsoft.com/default.asp?W1935>. Data reporting formats will be driven by project-specific requirements and may include the following:

- Flat file data dump for project analysis
- Cross tabular data
- Statistical analysis (maximum, minimum, average)
- Comparison against criteria (bold detects, highlight exceedances)

### **3.8.1 EPA Electronic Data Deliverable**

Data generated during the project will be submitted to EPA as an EQEDD. The DM, who assembles the EPA EQEDD, prepares the file for submission from the Jacobs EQulS database. Once the EDD files for a submission have been prepared, they must be checked for format compliance using Standalone EDP. Errors identified during this process must be resolved prior to submission to EPA.

### 3.8.2 Scribe format Data Deliverable

Data generated during the project will also be submitted as a Scribe formatted deliverable. The DM will assemble the Scribe EDD from the Jacobs EQulS database.

### 3.8.3 Spatial Data Deliverable

In addition to the EDD files, the preparation of site-specific geospatial features in an ESRI File GeoDatabase format ESRI Shapefile (.dbf, .shp, .shx, .prj,.xml) or tabular Excel/txt/csv/Access format. will be provided, consistent with Section IV.A.3 of the Statement of Work. The coordinate system required for these geospatial features is UTM relative to the NAD83 datum and in meters (to match the coordinates required in the EDD file for location information). These geospatial features should include all well locations and available waste management units, landfills, buildings, and roads appropriate to the site. No groundwater contours, contaminant contours, or other types of temporal information should be included with the geospatial features provided.

## 3.9 Data Corrective Action

Errors identified in data sources, work products, or the EQulS database require correction as part of the Data Correction Action workflow phase illustrated on Figure B-9. While various team member roles shown on Figure B-1 have responsibilities relating to data corrective actions, the DM serves as the central POC for data corrective actions. The general data corrective action steps are as follows:

- **Data Error Identification**—One or more team members on the project observe one or more data errors in data sources (field log books, field forms, data logger files, data entry templates, etc.) or work products (database exports, report tables, figures, charts, etc.).
- **DM Notification**—The team member who has identified the data error(s) sends an error notification to the DM. The DM notifies all three teams on the project of the error identification(s) (i.e., Project Team, Chemistry Team, and Database Team as defined in Section 1.1).
- **Corrective Action Determination**—The three teams review the error identification(s) and define/agree upon an appropriate corrective action(s).
- **EDP**—If the identified error(s) is present in the Jacobs EQulS database, the data containing the error(s) are exported in an EDD format using Professional EDP, then updated with the defined correction(s). The corrected data is then reloaded to the EQulS database using the updated EDD and the 'Update Only' commit type.
- **Manual Correction**—If the identified error(s) is present in the Jacobs EQulS database, the DM, DML, or DBA can manually correct data through EQulS Professional directly in the data table. While data can be corrected manually, the EDP update method is generally preferred to track data changes by ebatch.
- **EQulS Professional / EQulS Enterprise**—The corrected data is reported from the Jacobs EQulS database using either EQulS Professional or EQulS Enterprise to confirm that the appropriate correction(s) has been applied and the data are ready to report.
- **Data Source/ Work Product Correction**—Data sources and/or work products containing the identified error(s) are revised/notated according to the defined corrective action(s).

## Figures

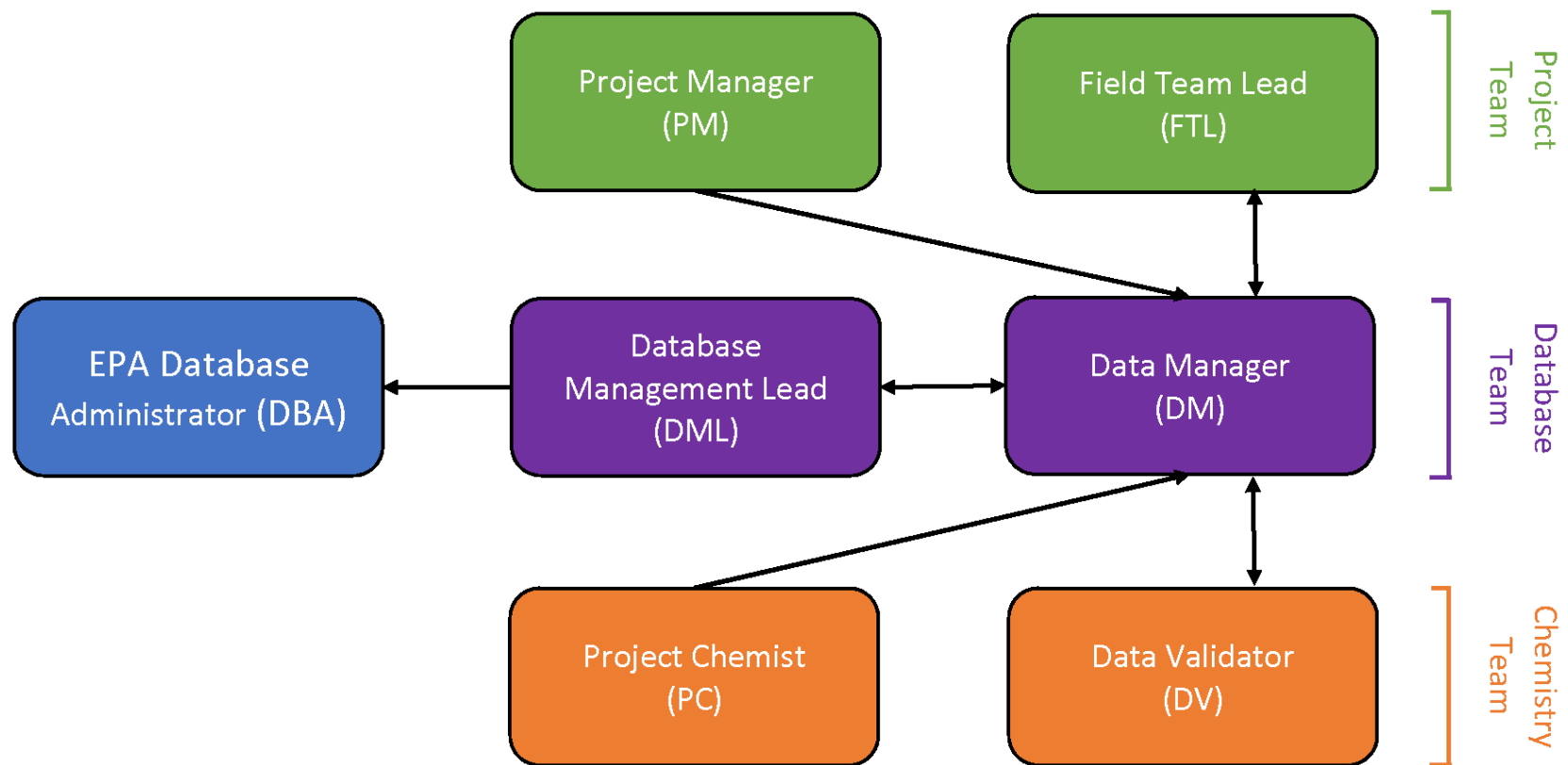


Figure B-1. Project Organizational Chart

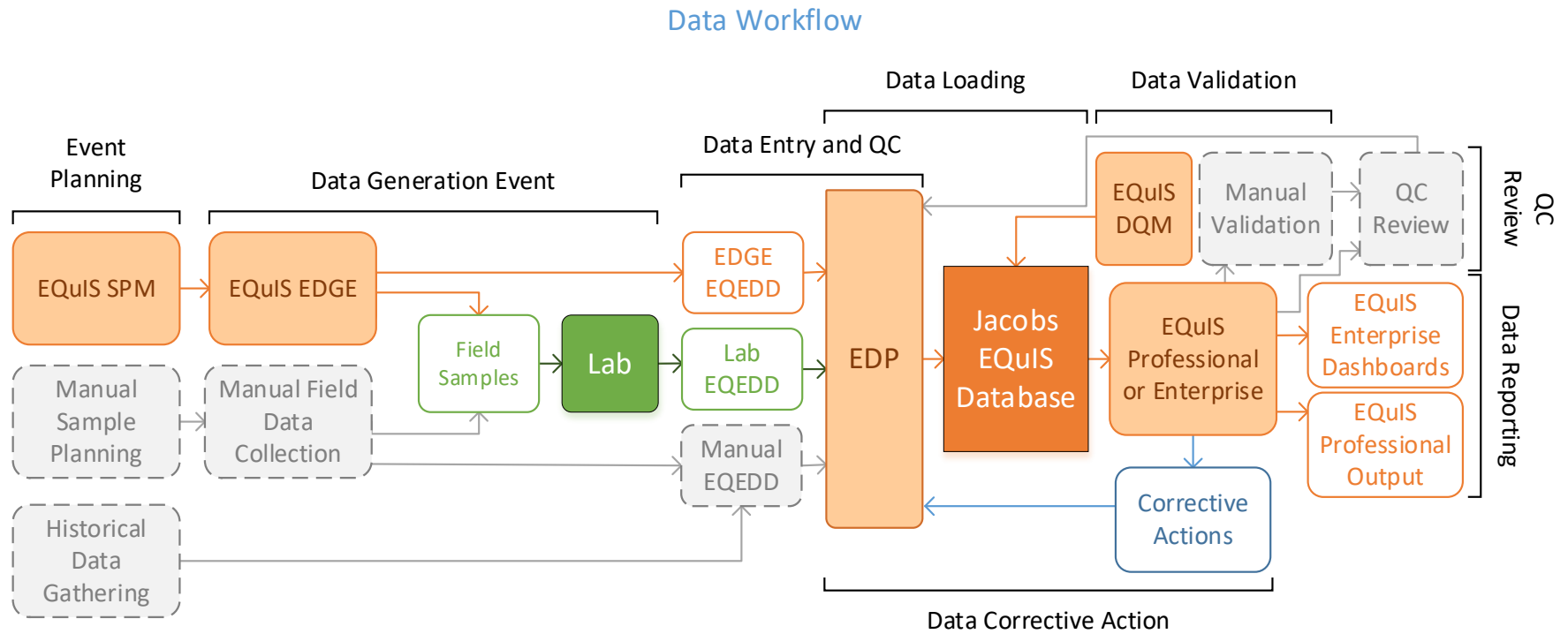


Figure B-2. Data Workflow

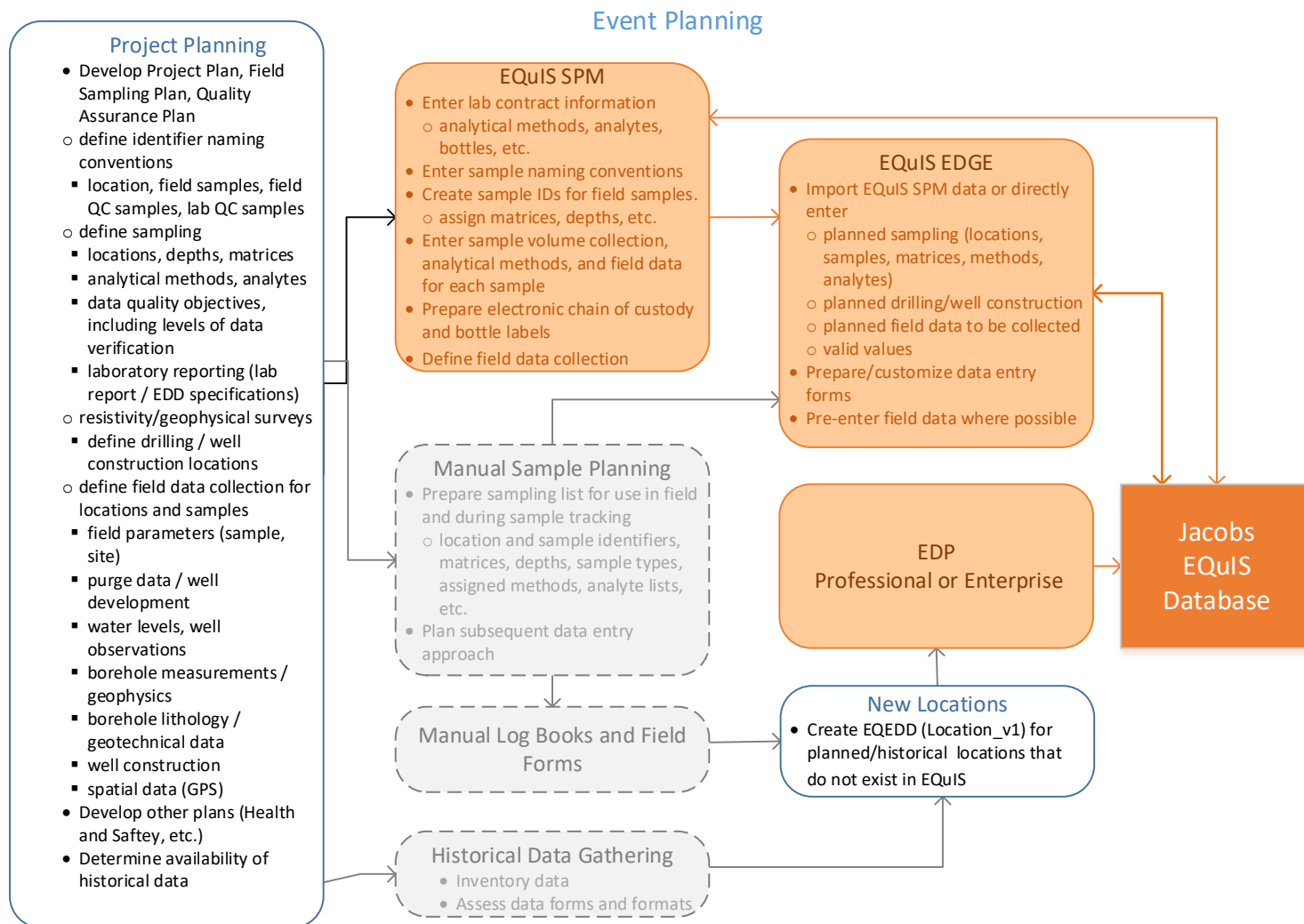


Figure B-3 Event Planning

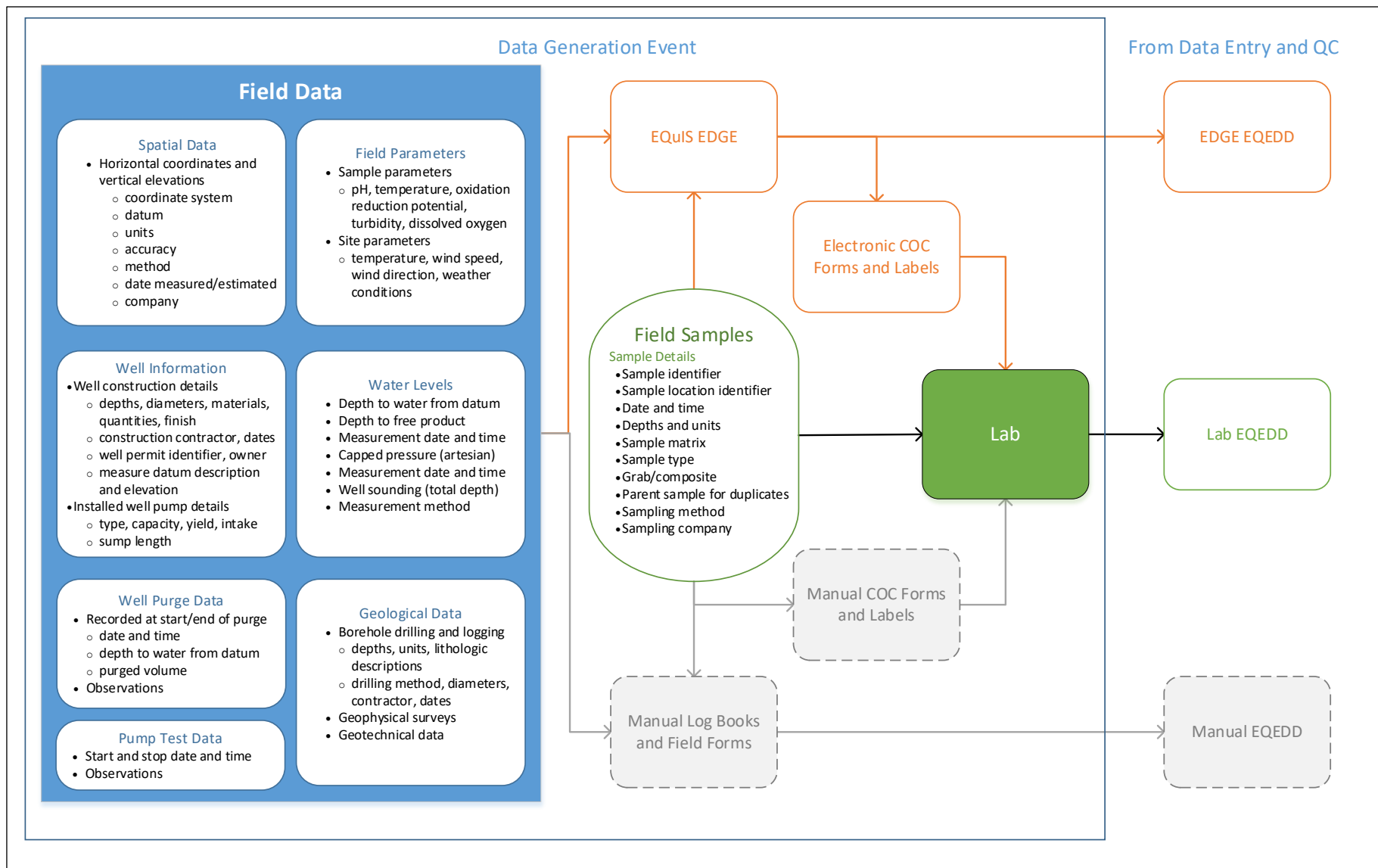


Figure B-4. Data Generation Event

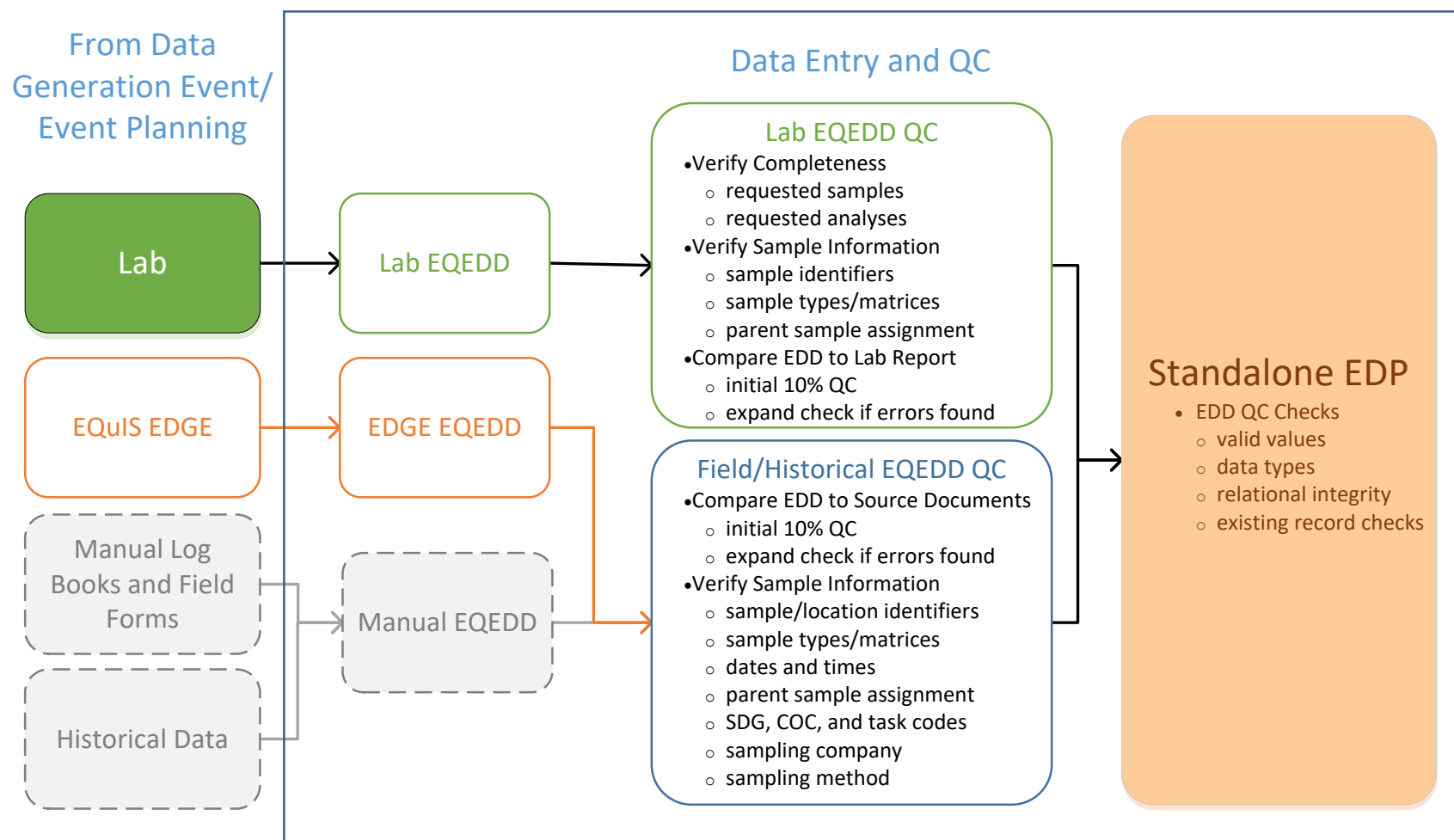


Figure B-5. Data Entry and Quality Control

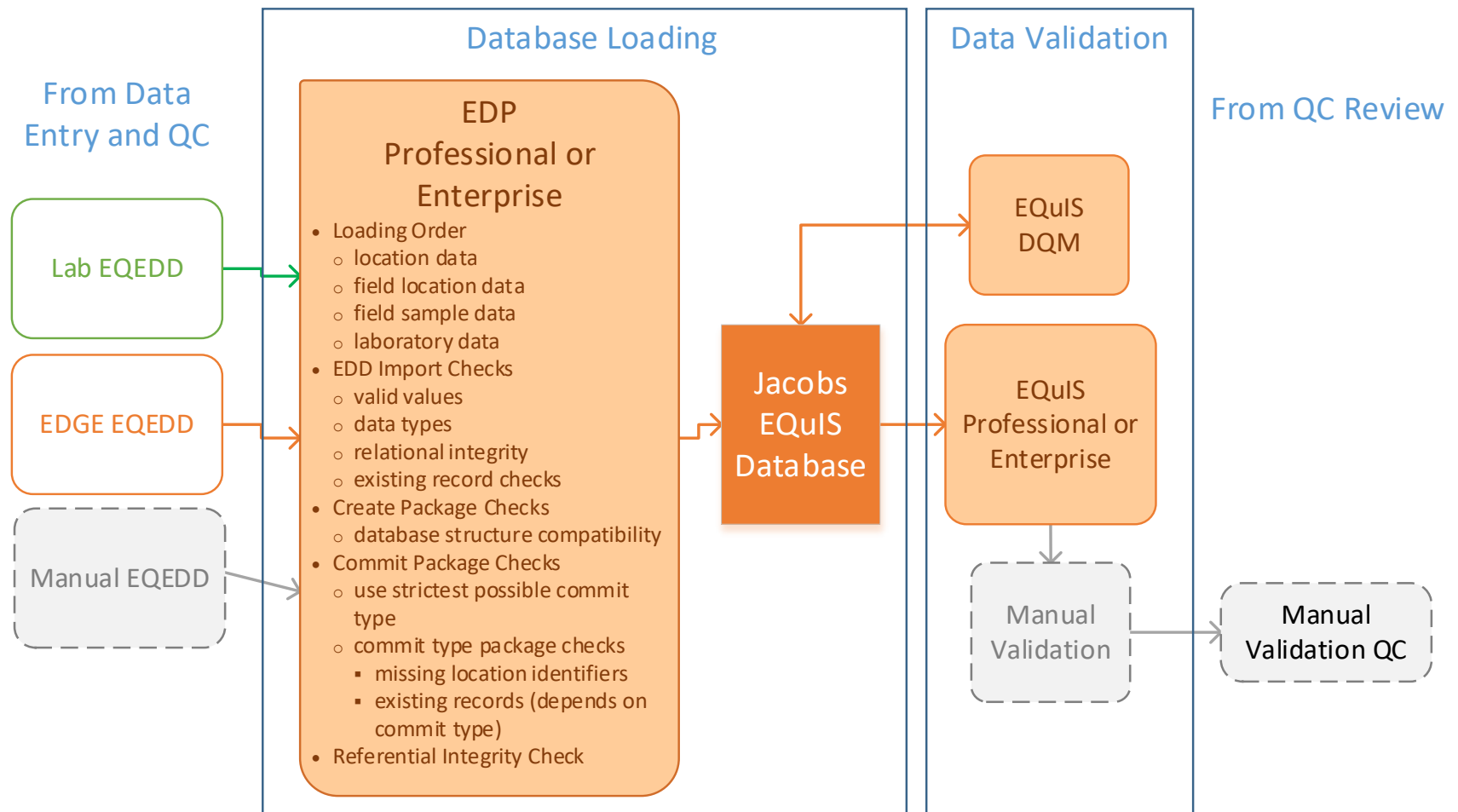


Figure B-6. Data Loading and Data Validation

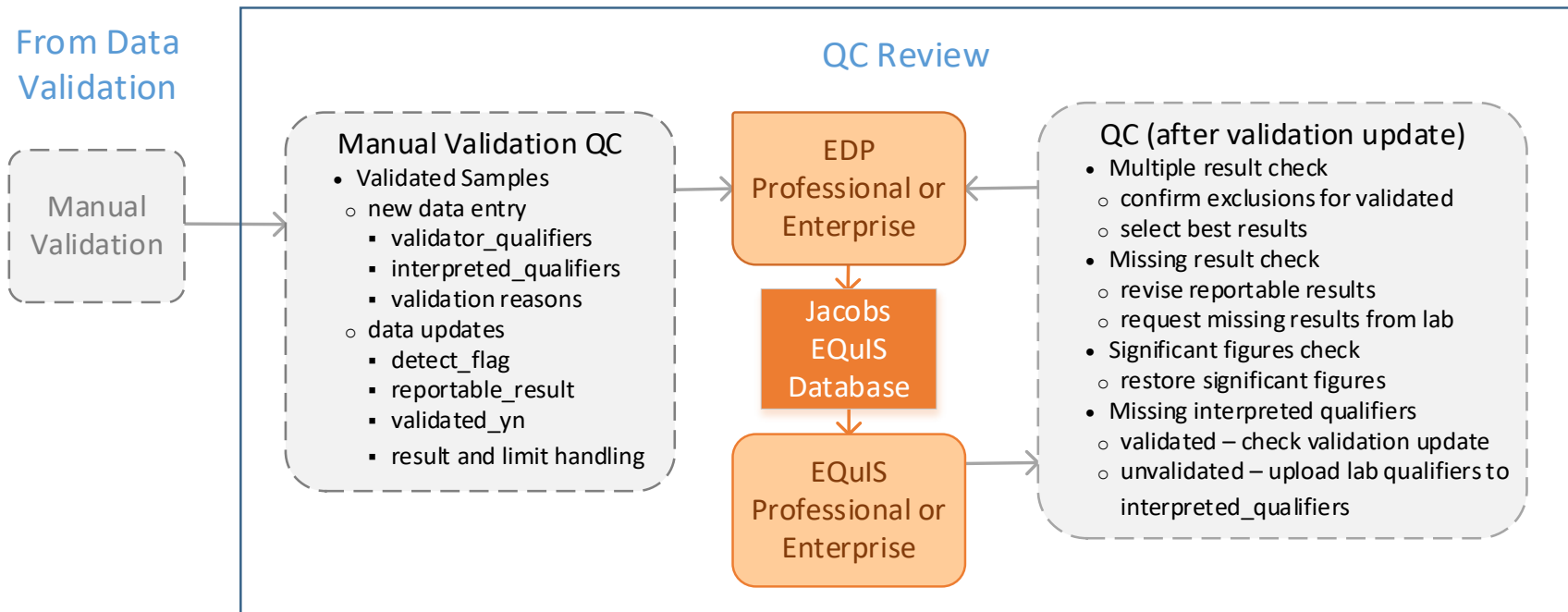


Figure B-7. Quality Control Review

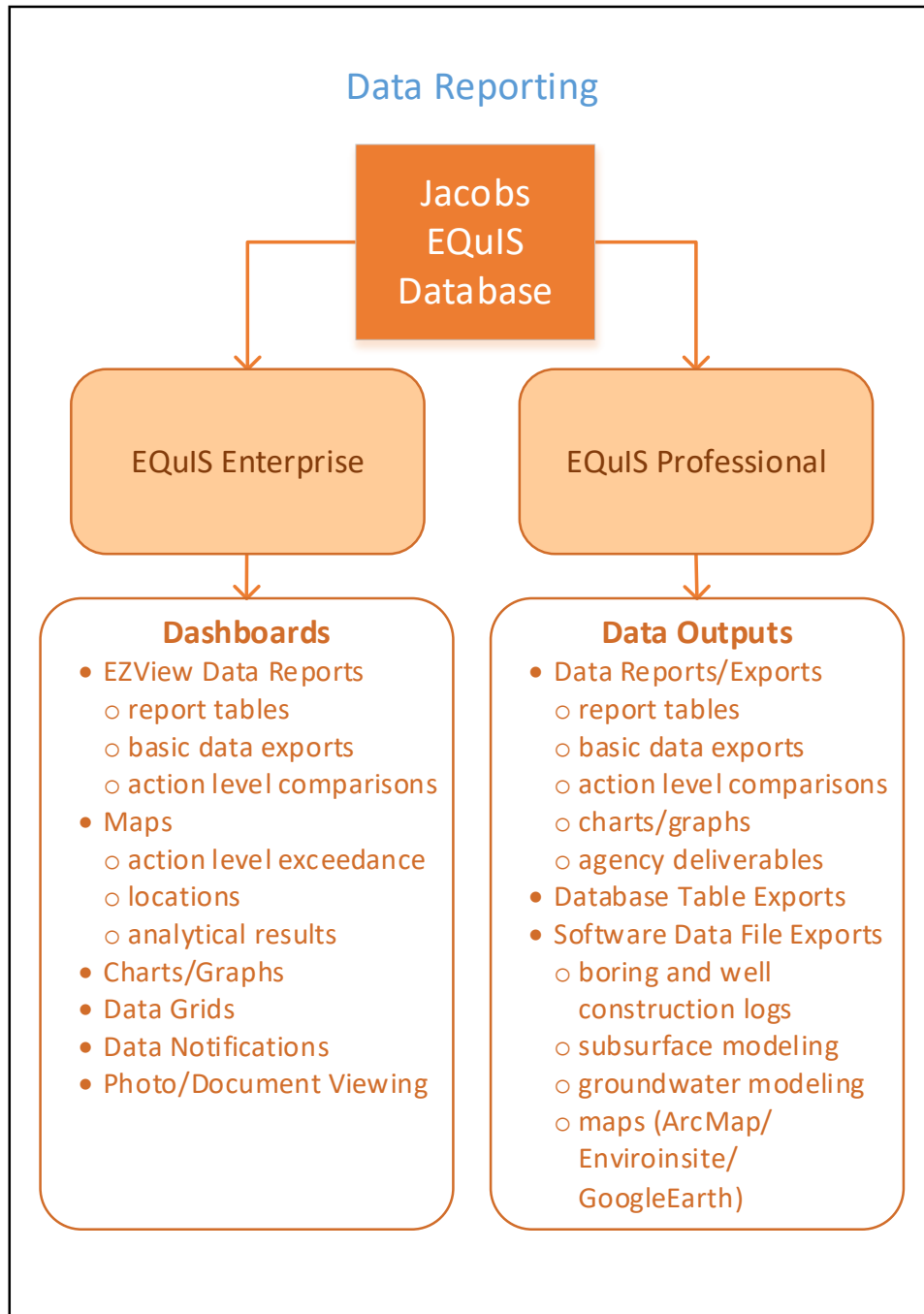


Figure B-8. Data Reporting

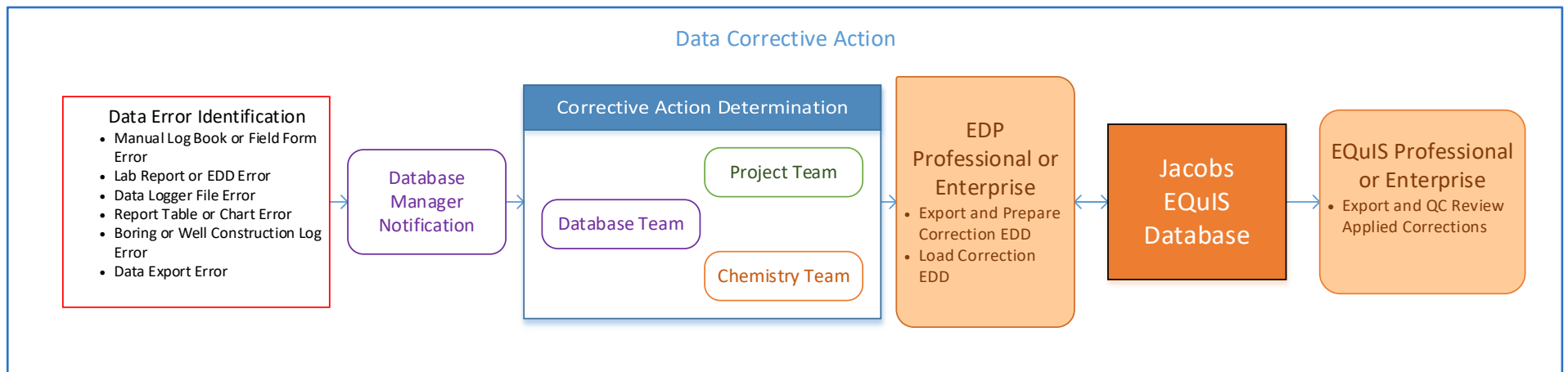


Figure B-9. Data Corrective Action

**Attachment B1**  
**Identifier Naming Conventions**

## Attachment B1. Identifier Naming Conventions

The following is an example set of naming conventions for location identifiers (IDs). It is essential to establish naming conventions at the beginning of a project to maintain consistency and ease of use and to avoid duplication of IDs (using location IDs as sample IDs can have unintended consequences in a relational database such as EQulS). Any project-specific nomenclature identified in the Quality Assurance Project Plan takes precedence.

EQulS stores sample IDs in two different fields: `sys_sample_code` and `sample_name`. Of these two fields, `sys_sample_code` must contain a unique sample ID for each sample loaded into the Jacobs Engineering Group Inc. (Jacobs) EQulS database.

### B1.1 Location ID Naming Convention

The naming convention for location IDs is shown below as a series of segments, each representing a specific piece of information about the location. The descriptions for each segment, as well as example location IDs, follows the depiction of the naming convention. Note that the EQEDD format limits location IDs to a maximum of 20 characters in the `sys_loc_code` field.

*[area code]*-**[location type]**-**[sequence number]***[designator]*

**Bold** = required

*Italics* = optional or as needed for ID uniqueness

Where:

*[area code]*- = code for site, property, or setting to which the location is assigned (e.g., '14-' for Site 14 or Property 14) - include as needed to establish unique location IDs within a single facility database.

**[location type]**- = project-specific code indicating the location type (e.g., 'MW-' for monitoring well).

**[sequence number]** = location sequence number in three-digit format so that location IDs will sort in alphanumeric order (e.g., '001' for the first location of a specific type)

*[designator]* = project-specific code to designate differences in grouped locations (e.g., 'S' for shallow aquifer screened interval and 'D' for deep aquifer screened interval in set of nested wells at same location)—include as needed to establish unique location IDs within a single facility database per project requirements.

Examples of location IDs created using the naming convention above are as follows:

- Example 1: Nested set of monitoring wells with screened intervals in the shallow, mid, and deep aquifers at a site:
  - MW-001S
  - MW-001M
  - MW-001D
- Example 2: Series of sampling ports along a flexible liner within monitoring well MW-014, two ports per depth interval:
  - MW-014A1
  - MW-014A2
  - MW-014B1
  - MW-014B2
  - MW-014C1
  - MW-014C2

- Example 3: Set of vapor intrusion study locations at Property 245:

- 245-SG-001 (soil gas)
- 245-SG-002 (soil gas)
- 245-SG-003 (soil gas)
- 245-IA-001 (indoor air)
- 245-OA-001 (outdoor air)
- 245-SSV-001 (sub-slab vapor)
- 245-SSV-002 (sub-slab vapor)

#### B.1.1.1 Sample ID Naming Convention

The naming conventions used for sample IDs vary by the type or nature of the sample to be collected and are described in the sections below. EQulS stores sample IDs in two different fields: `sys_sample_code` and `sample_name`. Of these two fields, `sys_sample_code` must contain a unique sample ID for each sample loaded into EQulS. For this reason, location IDs alone cannot be assigned as sample IDs in `sys_sample_code` because this does not allow for unique IDs for multiple samples collected from the same location (e.g., soil samples from specific depth intervals along a soil boring, groundwater samples collected routinely from a monitoring well, normal environmental and field duplicate samples collected from the same surface soil location, etc.). Note that the EQEDD format limits sample IDs to a maximum of 40 characters in the `sys_sample_code` field. Likewise, EQEDD format limits IDs in the `sample_name` field to a maximum of 50 characters.

#### B.1.1.2 Normal Environmental Sample and Field-Derived Quality Control Samples

The naming convention for normal environmental samples, as well as quality control (QC) samples derived from field-collected matrices, is shown below as a series of segments, each representing a specific piece of information about the sample. The descriptions for each segment, as well as example sample IDs, follows the depiction of the naming convention:

**[location ID]***\_[depth interval]\_[unit]***[sample date]***-[sample time]**[sample type]*

**Bold** = required

*Italics* = optional or as needed for ID uniqueness

Where:

**[location ID]** = location ID created in accordance with Section A.1 (e.g., 'MW-001').

*\_[depth interval]\_[unit]* = depth interval and unit for the following sample matrices/location types—include as needed to establish unique sample IDs within a single facility database:

- surface soil samples (e.g., '\_0-5ft' for zero to five feet)
- subsurface soil samples (e.g., '\_25.5-30.5ft' for 25.5 to 30.5 feet)
- sediment samples (e.g., '\_0.5-1ft' for 0.5 to one foot)
- groundwater from packer sampling intervals or sampling ports in wells (e.g., '\_1.5-4.3ft' for 1.5 to 4.3 feet)
- surface water samples from specific depth intervals along the water column of a surface water body (e.g., '\_0-0.5ft' for zero to 0.5 feet)

**[sample date]** = date sampled in '\_YYYYMMDD' format, where YYYY=4-digit year, MM=2-digit month, and DD=2-digit day (e.g., '\_20161201' for December 1, 2016).

*[sample time]* = time sampled; time in '-HHMM' format, where HH=hour in 24-hour designation, MM = minute in 24-hour designation (e.g., '-1402' for 2:02 PM)—include as needed to establish unique sample IDs within a single facility database.

*[sample type]* = code indicating the sample type (e.g., 'FD' for field duplicate sample); applicable sample type codes are as follows:

- FD—field duplicate
- MS—matrix spike
- MSD—matrix spike duplicate
- LR—laboratory replicate

Examples of sample IDs created using the naming convention for normal environmental samples and field-derived QC samples are as follows:

- Example 1: Normal environmental sample and associated field duplicate sample collected from soil boring location 14-SB-001 at a depth interval of 1 to 10 feet below ground surface on December 1, 2016:
  - 14-SB-001\_1-10ft\_20161201
  - 14-SB-001\_1-10ft\_20161201FD
- Example 2: Normal environmental sample and associated matrix spike, matrix spike duplicate, and laboratory replicate samples from monitoring well MW-007 on November 16, 2016:
  - MW-007\_20161116
  - MW-007\_20161116MS
  - MW-007\_20161116MSD
  - MW-007\_20161116LR
- Example 3: Normal environmental samples collected from surface water location SW-025 on October 31, 2016, at 8:59 AM, 10:30 AM, and 1:15 PM, and an associated field duplicate sample collected at 1:15PM sampling time:
  - SW-025\_20161031-0859
  - SW-025\_20161031-1030
  - SW-025\_20161031-1315
  - SW-025\_20161031-1315FD
- Example 4: Normal environmental samples collected from monitoring well MW-023S on August 2, 2016, at packer intervals of 25 to 27, 28 to 31.5, and 33.5 to 35.5 feet below top of casing:
  - MW-023S\_25-27ft\_20160802
  - MW-023S\_28-31.5ft\_20160802
  - MW-023S\_33.5-35.5ft\_20160802

### Field QC Blank Samples

The naming convention for field QC blank samples is shown below as a series of segments, each representing a specific piece of information about the sample. The descriptions for each segment, as well as example sample IDs, follows the depiction of the naming convention.

**[sample type]**\_**[sample date]**-*[sequential number]*

**Bold** = required

*Italics* = optional or as needed for ID uniqueness

Where:

**[sample type]** = code indicating the sample type (e.g., 'TB' for trip blank sample); commonly used sample type codes from the EPA Region 5 reference value list are as follows:

- TB—trip blank
- FEB—field equipment blank or rinsate blank
- AB—ambient conditions blank
- FB—field blank
- MB—material blank

**\_[sample date]** = date sampled in '\_YYYYMMDD' format, where YYYY=4-digit year, MM=2-digit month, and DD=2-digit day (e.g., '\_20161201' for December 1, 2016)

**-[sequential number]** = sequential number as needed to distinguish multiple QC blank samples of the same type collected on the same day (e.g., '-1' for the first, '-2' for the second, etc.)

Examples of sample IDs created using the naming convention for field QC blank samples are as follows:

- Example 1: One trip blank, one equipment blank, and one ambient conditions blank collected on December 1, 2016:
  - TB\_20161201
  - FEB\_20161201
  - AB\_20161201
- Example 2: Three trip blanks collected on December 2, 2016:
  - TB\_20161202-1
  - TB\_20161202-2
  - TB\_20161202-3

### Investigation-Derived Waste Samples

The naming convention for investigation-derived waste (IDW) samples is shown below as a series of segments, each representing a specific piece of information about the sample. The descriptions for each segment, as well as example sample IDs, follows the depiction of the naming convention.

*[area code]-IDW\_[sample matrix]\_[sample date]-[sequential number]*

**Bold** = required

*Italics* = optional or as needed for ID uniqueness

Where:

*[area code]* = code for site, property, or setting from which the IDW was specifically generated (e.g., '14-' for Site 14 or Property 14)—include as needed to establish unique sample IDs within a single facility database.

**IDW** = acronym for investigation-derived waste

**\_[sample matrix]** = code indicating the sample matrix (e.g., 'ST' for mixture of different solid matrices like soil and sediment); commonly used sample matrix codes from the EPA Region 5 reference value list are as follows:

Use if sample contains mixtures of different solid matrices or different aqueous matrices:

- ST—solid waste
- WW—waste water

Use if sample contains only a specific matrix:

- SO—soil
- SE—sediment
- WG—groundwater
- WS—surface water

**\_[sample date]** = date sampled in ‘\_YYYYMMDD’ format, where YYYY=4-digit year, MM=2-digit month, and DD=2-digit day (e.g., ‘\_20161201’ for December 1, 2016)

**-[sequential number]** = sequential number as needed to distinguish multiple IDW samples of the same matrix collected on the same day (e.g., ‘-1’ for the first, ‘-2’ for the second, etc.)

Examples of sample IDs created using the naming convention for investigation derived waste samples are as follows:

- Example 1: One solid IDW sample and one aqueous IDW sample collected on December 1, 2016, from waste collected during field activities conducted at Site 14:
  - 14-IDW\_ST\_20161201
  - 14-IDW\_WW\_20161201
- Example 2: Two soil IDW samples collected on June 15, 2016, from waste collected during field activities across the facility (not isolated to a single site):
  - IDW\_SO\_20160615-1
  - IDW\_SO\_20160615-2

#### B.1.1.3 Laboratory QC Sample IDs

The naming convention for laboratory QC samples not derived from field-collected matrices is shown below as a series of segments, each representing a specific piece of information about the sample. The descriptions for each segment, as well as example sample IDs, follows the depiction of the naming convention. Use of this naming convention requires coordination with labs contracted for sample analysis on the project.

**[laboratory sample ID]\_[laboratory work order number][sample type]**

**Bold** = required

Where:

**[laboratory sample ID]** = laboratory-generated sample ID for laboratory QC samples (e.g., ‘LCS 451-393528/21’ for a laboratory control sample).

**\_[laboratory work order number]** = laboratory-assigned code for group of samples processed and reported together, also known as a sample delivery group (SDG) number (e.g., ‘\_450-118512-4’ for SDG 450-118512-4).

**[sample type]** = code indicating the sample type (e.g., ‘LB’ for method blank sample); commonly used sample type codes from the EPA Region 5 reference value list are as follows:

- LB—method blank
- BS—blank spike
- BD—blank spike duplicate

Examples of sample IDs created using the naming convention for laboratory QC samples not derived from field-collected matrices are as follows:

- Example 1: Blank spike and blank spike duplicate samples from laboratory work order number (SDG) 450-118512-4:
  - LCS450-321499/3\_450-118512-4BS
  - LCSD450-321499/4\_450-118512-4BD
- Example 2: Method blank and blank spike samples from laboratory work order number (SDG) TC89382:
  - VK1756-MS\_TC89382LB
  - VK1756-BS\_TC89382BS

**Attachment B2**  
**Quality Control Review**

## Attachment B2. Quality Control Review

### B2.1 Manual Data Validation Entry

Manual data validation requires hand entry of validation information into the electronic laboratory data. The approach to this data entry varies depending on whether a particular sample type and result type receives qualification as part of the data validation (that is, those that may be qualified are considered validated result records, while the remainder are considered unvalidated result records). The following details this approach, while Tables B-1 through B-4 illustrate data examples.

- Validated result records—results to which qualifiers are typically applied during validation (see applicable sample types and result types below)—see data examples before validation entry in Table B-1 and after validation entry in Table B-2

*Sample types: normal, field duplicate*

*Result types: target, tentatively identified compound*

- New data entry:
  - validator\_qualifiers—enter final validator qualifiers and any laboratory qualifiers that should be applied to the final result
  - interpreted\_qualifiers—enter the final validator qualifiers
  - result\_comment field in TestResults\_v1 and TestResultsQC\_v1 (dt\_result table in EQuIS)—enter validation reason code, if used and applicable
- Data updates:
  - validated\_yn—change to 'Y'
  - reportable\_result—change to 'No' for excluded results, used to distinguish between multiple results such as dilutions or reanalysis (keep reportable\_result 'Yes' for rejected results to include the 'R' qualifier for reporting, otherwise rejected results will not report)
  - FOR SAMPLE EVALUATION AND SELECTION OF FINAL RESULT FOR REPORTING when multiple results are considered reportable (samples analyzed by multiple methods or techniques, e.g., standard and SIM, trace and low-level)—coordinate with database manager and store in a custom field in EQuIS
  - FOR DETECTED RESULTS THAT ARE CHANGED TO NON-DETECTED RESULTS DURING VALIDATION—see example data row 13 in Table B-2
    - result\_value in EDD, or result\_text and result\_numeric in the JacobsEQuIS database—remove the original result value (leave null); enter the value to which the nondetect result should be reported in the reporting\_detection\_limit
    - detect\_flag—change to 'N'
    - result\_comment—note changes in result\_value, reporting\_detection\_limit, and detect\_flag fields, along with the original value that was in each
- Unvalidated result records—results to which qualifiers are ***not*** typically applied during validation (see applicable sample types and result types below)—see data examples before entry in Table B-3 and after entry in Table B-4, as well as surrogate result examples for normal environmental samples in Table B-1 and Table B-2

*Sample types: trip blank, equipment blank, ambient conditions blank, method blank, holding blank, laboratory replicate, matrix spike, matrix spike duplicate, blank spike, blank spike duplicate, post-digestion spike*

*Result types: target and tentatively identified compound for non-spike samples, spiked compound results for spike samples, surrogates for all sample types, internal standards for all sample types*

- New data entry:
  - interpreted\_qualifiers—enter laboratory qualifiers
  - Do not enter qualifiers into validator\_qualifiers field, and leave validated\_yn as 'N'

## B2.2 Pre-Reporting Quality Control Review

The following pre-reporting checks assure that both validated data and unvalidated data in the Jacobs Engineering Group Inc. (Jacobs) EQuIS database are ready to report. Data can be exported from the Jacobs EQuIS database using either EQuIS Professional, EQuIS Enterprise, or EDP to make these QC review checks easier to perform.

- 1) Multiple result check: Find where more than one result is set to report per sample and analyte; the following should be considered to resolve multiple results:
  - Confirm validation exclusions: check that results excluded by validator are set to not report (i.e., reportable\_result = 'No')
  - Select best results: where multiple acceptable results are present, select one to report; note that the approval\_code field may need to be integrated with the overall criteria used to query data from the Jacobs EQuIS database in order for the best result selections to correctly report
    - Select a single 'best result' for reporting using a process approved by the project and chemistry teams
    - Record the selection of 'best result' by entering a 'Y' in the approval\_code field, enter 'N' into approval\_code field for other results not selected
    - Complete entry in the approval\_code field for non-multiple results using reportable\_result field as guide (enter 'Y' where reportable\_result = 'Yes', enter 'N' where reportable\_result = 'No')
- 2) Missing result check: find where no result is set to report per sample and analyte; the following should be considered to resolve missing results:
  - Revise reportable results: review values in the reportable\_result field in conjunction with the laboratory and final validator qualifiers, then adjust in consultation with the chemistry and project teams
  - Revise best results: if made, review best result selections in the approval\_code field and adjust in consultation with the chemistry and project teams
  - Request missing results from laboratory: confirm that result is missing from the Jacobs EQuIS database and original laboratory EDD, then begin data corrective action process for identified error and contact the laboratory to request revised deliverables (EDD, as well as laboratory report if needed)
- 3) Significant figures check: find where trailing zeros have been lost in comparison to source documents (e.g., laboratory reports); the following should be considered to resolve significant figure issues:
  - Restore significant figures: use source electronic data files or reports to directly or indirectly restore significant figures (export data, update result- and limit-related fields, then re-load to the Jacobs EQuIS database using EDP).
- 4) Missing interpreted\_qualifiers check: confirm that the appropriate qualifier is entered into the interpreted\_qualifiers field, whether final validator qualifiers for validated result records or the laboratory qualifier for unvalidated result records; the following should be considered to resolve missing interpreted\_qualifier values
  - Check validation update: confirm that validator\_qualifiers and interpreted\_qualifiers fields in the Jacobs EQuIS database were correctly updated with the final validator qualifiers for validated result records.
  - Upload laboratory qualifiers: prepare and load an update EDD for unvalidated result records to place the laboratory qualifier in the interpreted\_qualifiers field.

Table B-1. Laboratory Data before Data Validation Entry – Normal Environmental Samples and Field Duplicate Samples

UNVALIDATED DATA FROM ORIGINAL TESTRESULTSQC\_v1 EDD WITH NON-DETECTS REPORTED TO THE ADJUSTED METHOD DETECTION LIMIT.

| Row No. | #sys_sample_code  | test_type  | cas_rn     | chemical_name                | result_value | result_type_code | reportable_result | detect_flag | lab_qualifiers | validator_qualifiers | interpreted_qualifier | method_detection_limit | reporting_detection_limit | quantitation_limit | result_unit | detection_limit_unit | result_comment | custom_field_2 |
|---------|-------------------|------------|------------|------------------------------|--------------|------------------|-------------------|-------------|----------------|----------------------|-----------------------|------------------------|---------------------------|--------------------|-------------|----------------------|----------------|----------------|
| 1       | MW-007 20161116   | INITIAL    | 108-88-3   | Toluene                      | 106          | TRG              | No                | Y           | E              |                      |                       |                        |                           |                    |             |                      |                |                |
| 2       | MW-007 20161116   | DILUTION1  | 108-88-3   | Toluene                      | 393          | TRG              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 3       | MW-007 20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               | 212          | TRG              | No                | Y           | E              |                      |                       |                        |                           |                    |             |                      |                |                |
| 4       | MW-007 20161116   | DILUTION1  | 1330-20-7  | Xylenes, Total               | 44.2         | TRG              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 5       | MW-007 20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 6       | MW-007 20161116   | DILUTION1  | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 7       | MW-010 20161116   | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 8       | MW-010 20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 9       | MW-010 20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 10      | MW-120 20161116   | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 11      | MW-120 20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 12      | MW-120 20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 13      | MW-200 20161116   | INITIAL    | 108-88-3   | Toluene                      | 0.682        | TRG              | Yes               | Y           | J              |                      |                       |                        |                           |                    |             |                      |                |                |
| 14      | MW-200 20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 15      | MW-200 20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 16      | MW-248 20161116   | INITIAL    | 108-88-3   | Toluene                      | 7620         | TRG              | No                | Y           | E              |                      |                       |                        |                           |                    |             |                      |                |                |
| 17      | MW-248 20161116   | REANALYSIS | 108-88-3   | Toluene                      | 69700        | TRG              | No                | Y           | HE             |                      |                       |                        |                           |                    |             |                      |                |                |
| 18      | MW-248 20161116   | DILUTION1  | 108-88-3   | Toluene                      | 89800        | TRG              | Yes               | Y           | H              |                      |                       |                        |                           |                    |             |                      |                |                |
| 19      | MW-248 20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               | 10700        | TRG              | No                | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 20      | MW-248 20161116   | REANALYSIS | 1330-20-7  | Xylenes, Total               | 11800        | TRG              | No                | Y           | H              |                      |                       |                        |                           |                    |             |                      |                |                |
| 21      | MW-248 20161116   | DILUTION1  | 1330-20-7  | Xylenes, Total               | 7870         | TRG              | Yes               | Y           | JH             |                      |                       |                        |                           |                    |             |                      |                |                |
| 22      | MW-248 20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 23      | MW-248 20161116   | REANALYSIS | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 24      | MW-248 20161116   | DILUTION1  | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 29      | MW-350 20161116   | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 28      | MW-350 20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 30      | MW-350 20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |
| 27      | MW-350 20161116FD | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 26      | MW-350 20161116FD | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      |                       |                        |                           |                    |             |                      |                |                |
| 25      | MW-350 20161116FD | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                           |                    |             |                      |                |                |

Table B-2. Laboratory Data after Data Validation Entry – Normal Environmental Samples and Field Duplicate Samples

DATA VALIDATION ENTRIES INDICATED BY HIGHLIGHTED CELLS WITH BOLDED AND ITALICIZED FONT ENTERED INTO THE ORIGINAL TESTRESULTSQC\_v1 EDD. NOTE THAT THE SURROGATE RESULTS DO NOT GET QUALIFIED DURING VALIDATION. NON-DETECTS ARE REPORTED TO THE ADJUSTED METHOD DETECTION LIMIT.

| Row No. | #sys_sample_code  | test_type  | cas_rn     | chemical_name                | result_value | result_type_code | reportable_result | detect_flag | lab_qualifiers | validator_qualifiers | interpreted_qualifier | method_detection_limit | method_detection_limit | quantitation_limit | result_unit | detection_limit_unit | result_comment  | custom_field_2 |
|---------|-------------------|------------|------------|------------------------------|--------------|------------------|-------------------|-------------|----------------|----------------------|-----------------------|------------------------|------------------------|--------------------|-------------|----------------------|---|----------------|
| 1       | MW-007_20161116   | INITIAL    | 108-88-3   | Toluene                      | 106          | TRG              | No                | Y           | E              | Exclude              | X                     | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |   |                |
| 2       | MW-007_20161116   | DILUTION1  | 108-88-3   | Toluene                      | 393          | TRG              | Yes               | Y           |                |                      |                       | 3.40                   | 3.40                   | 20.0               | ug/l        | ug/l                 |   | Use dilution   |
| 3       | MW-007_20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               | 212          | TRG              | No                | Y           | E              | Exclude              | X                     | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |   |                |
| 4       | MW-007_20161116   | DILUTION1  | 1330-20-7  | Xylenes, Total               | 44.2         | TRG              | Yes               | Y           |                |                      |                       | 3.80                   | 3.80                   | 40.0               | ug/l        | ug/l                 |   | Use dilution   |
| 5       | MW-007_20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 6       | MW-007_20161116   | DILUTION1  | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 7       | MW-010_20161116   | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |   |                |
| 8       | MW-010_20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |   |                |
| 9       | MW-010_20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 10      | MW-120_20161116   | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |   | HT>UCL         |
| 11      | MW-120_20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |   | HT>UCL         |
| 12      | MW-120_20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 13      | MW-200_20161116   | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | J              | U                    | U                     | 0.170                  | 0.682                  | 1.00               | ug/l        | ug/l                 | FML161210: detect_flag Y to N per DV, moved result_value 0.682 ug/l to reporting_detection_limit per DV | TB<RL (0.682)  |
| 14      | MW-200_20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |   |                |
| 15      | MW-200_20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 16      | MW-248_20161116   | INITIAL    | 108-88-3   | Toluene                      | 7620         | TRG              | No                | Y           | E              | Exclude              | X                     | 6.80                   | 6.80                   | 40.0               | ug/l        | ug/l                 |   | Use dilution   |
| 17      | MW-248_20161116   | REANALYSIS | 108-88-3   | Toluene                      | 69700        | TRG              | No                | Y           | HE             | Exclude              | X                     | 170                    | 170                    | 1000               | ug/l        | ug/l                 |   | Exclude        |
| 18      | MW-248_20161116   | DILUTION1  | 108-88-3   | Toluene                      | 89800        | TRG              | Yes               | Y           | H              | J                    | J                     | 680                    | 680                    | 4000               | ug/l        | ug/l                 |   | HT>UCL         |
| 19      | MW-248_20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               | 10700        | TRG              | No                | Y           |                | Exclude              | X                     | 7.60                   | 7.60                   | 80.0               | ug/l        | ug/l                 |   | Exclude        |
| 20      | MW-248_20161116   | REANALYSIS | 1330-20-7  | Xylenes, Total               | 11800        | TRG              | Yes               | Y           | H              | J                    | J                     | 190                    | 190                    | 2000               | ug/l        | ug/l                 | FML161210: reportable_result No to Yes per DV   | HT>UCL         |
| 21      | MW-248_20161116   | DILUTION1  | 1330-20-7  | Xylenes, Total               | 7870         | TRG              | No                | Y           | JH             | Exclude              | X                     | 760                    | 760                    | 8000               | ug/l        | ug/l                 | FML161210: reportable_result Yes to No per DV   | Exclude        |
| 22      | MW-248_20161116   | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 23      | MW-248_20161116   | REANALYSIS | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 24      | MW-248_20161116   | DILUTION1  | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 25      | MW-350_20161116   | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |   |                |
| 26      | MW-350_20161116   | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |   |                |
| 27      | MW-350_20161116FD | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |
| 28      | MW-350_20161116FD | INITIAL    | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |   |                |
| 29      | MW-350_20161116FD | INITIAL    | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              | U                    | U                     | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |   |                |
| 30      | MW-350_20161116FD | INITIAL    | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |   |                |

Table B-3. Unvalidated Laboratory Data before Interpreted\_Qualifiers Entry – Field QC Blank and Laboratory QC Samples

UNVALIDATED DATA FROM ORIGINAL TESTRESULTSQC\_v1 EDD WITH NON-DETECTS REPORTED TO THE ADJUSTED METHOD DETECTION LIMIT.

*Trip Blank Sample*

| Row No. | #sys_sample_code | test_type | cas_rn     | chemical_name                | result_value | result_type_code | reportable_result | detect_flag | lab_qualifiers | validator_qualifiers | interpreted_qualifier | method_detection_limit | method_detection_limit | quantitation_limit | result_unit | detection_limit_unit | result_comment | custom_field_2 |
|---------|------------------|-----------|------------|------------------------------|--------------|------------------|-------------------|-------------|----------------|----------------------|-----------------------|------------------------|------------------------|--------------------|-------------|----------------------|----------------|----------------|
| 1       | TB_20161116      | INITIAL   | 108-88-3   | Toluene                      | 0.193        | TRG              | Yes               | Y           | J              |                      |                       | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |                |                |
| 2       | TB_20161116      | INITIAL   | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      |                       | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |                |                |
| 3       | TB_20161116      | INITIAL   | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |                |                |

*Method Blank Sample*

| Row No. | #sys_sample_code            | test_type | cas_rn     | chemical_name                | result_value | result_type_code | reportable_result | detect_flag | lab_qualifiers | validator_qualifiers | interpreted_qualifier | method_detection_limit | method_detection_limit | quantitation_limit | result_unit | detection_limit_unit | result_comment | custom_field_2 |
|---------|-----------------------------|-----------|------------|------------------------------|--------------|------------------|-------------------|-------------|----------------|----------------------|-----------------------|------------------------|------------------------|--------------------|-------------|----------------------|----------------|----------------|
| 4       | MB 760-253574/7_760804441LB | INITIAL   | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      |                       | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |                |                |
| 5       | MB 760-253574/7_760804441LB | INITIAL   | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              |                      |                       | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |                |                |
| 6       | MB 760-253574/7_760804441LB | INITIAL   | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |                |                |

*Blank Spike/Blank Spike Duplicate Samples*

| Row No. | #sys_sample_code             | test_type | cas_rn     | chemical_name                | result_value | result_type_code | reportable_result | detect_flag | lab_qualifiers | validator_qualifiers | interpreted_qualifier | method_detection_limit | method_detection_limit | quantitation_limit | result_unit | detection_limit_unit | result_comment | custom_field_2 |
|---------|------------------------------|-----------|------------|------------------------------|--------------|------------------|-------------------|-------------|----------------|----------------------|-----------------------|------------------------|------------------------|--------------------|-------------|----------------------|----------------|----------------|
| 7       | LCS 760-253574/3_760804441BS | INITIAL   | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |                |                |
| 8       | LCS 760-253574/3_760804441BS | INITIAL   | 108-88-3   | Toluene                      |              | SC               | Yes               | Y           |                |                      |                       | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |                |                |
| 9       | LCS 760-253574/3_760804441BS | INITIAL   | 1330-20-7  | Xylenes, Total               |              | SC               | Yes               | Y           |                |                      |                       | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |                |                |
| 10      | LCS 760-253574/4_760804441BD | INITIAL   | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |                |                |
| 11      | LCS 760-253574/4_760804441BD | INITIAL   | 108-88-3   | Toluene                      |              | SC               | Yes               | Y           |                |                      |                       | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |                |                |
| 12      | LCS 760-253574/4_760804441BD | INITIAL   | 1330-20-7  | Xylenes, Total               |              | SC               | Yes               | Y           |                |                      |                       | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |                |                |

Table B-4. Unvalidated Laboratory Data after Interpreted\_Qualifiers Entry – Field QC Blank and Laboratory QC Samples

ENTRIES OF LABORATORY QUALIFIERS INTO INTERPRETED\_QUALIFIERS FIELD INDICATED BY HIGHLIGHTED CELLS WITH BOLD AND ITALICIZED FONT ENTERED INTO THE ORIGINAL TESTRESULTSQC\_v1 EDD. NON-DETECTS ARE REPORTED TO THE ADJUSTED METHOD DETECTION LIMIT.

**Trip Blank Sample**

| Row No. | #sys_sample_code | test_type | cas_rn     | chemical_name                | result_value | result_type_code | reportable_result | detect_flag | lab_qualifiers | validated_qualifiers | interpreted_qualifier | method_detection_limit | method_detection_limit | quantitation_limit | result_unit | detection_limit_unit | result_comment | custom_field_2 |
|---------|------------------|-----------|------------|------------------------------|--------------|------------------|-------------------|-------------|----------------|----------------------|-----------------------|------------------------|------------------------|--------------------|-------------|----------------------|----------------|----------------|
| 1       | TB_20161116      | INITIAL   | 108-88-3   | Toluene                      | 0.193        | TRG              | Yes               | Y           | J              |                      | J                     | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |                |                |
| 2       | TB_20161116      | INITIAL   | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      | <b><i>U</i></b>       | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |                |                |
| 3       | TB_20161116      | INITIAL   | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |                |                |

**Method Blank Sample**

| Row No. | #sys_sample_code            | test_type | cas_rn     | chemical_name                | result_value | result_type_code | reportable_result | detect_flag | lab_qualifiers | validated_qualifiers | interpreted_qualifier | method_detection_limit | method_detection_limit | quantitation_limit | result_unit | detection_limit_unit | result_comment | custom_field_2 |
|---------|-----------------------------|-----------|------------|------------------------------|--------------|------------------|-------------------|-------------|----------------|----------------------|-----------------------|------------------------|------------------------|--------------------|-------------|----------------------|----------------|----------------|
| 4       | MB 760-253574/7_760804441LB | INITIAL   | 1330-20-7  | Xylenes, Total               |              | TRG              | Yes               | N           | U              |                      | <b><i>U</i></b>       | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |                |                |
| 5       | MB 760-253574/7_760804441LB | INITIAL   | 108-88-3   | Toluene                      |              | TRG              | Yes               | N           | U              |                      | <b><i>U</i></b>       | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |                |                |
| 6       | MB 760-253574/7_760804441LB | INITIAL   | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |                |                |

**Blank Spike/Blank Spike Duplicate Samples**

| Row No. | #sys_sample_code             | test_type | cas_rn     | chemical_name                | result_value | result_type_code | reportable_result | detect_flag | lab_qualifiers | validated_qualifiers | interpreted_qualifier | method_detection_limit | method_detection_limit | quantitation_limit | result_unit | detection_limit_unit | result_comment | custom_field_2 |
|---------|------------------------------|-----------|------------|------------------------------|--------------|------------------|-------------------|-------------|----------------|----------------------|-----------------------|------------------------|------------------------|--------------------|-------------|----------------------|----------------|----------------|
| 7       | LCS 760-253574/3_760804441BS | INITIAL   | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |                |                |
| 8       | LCS 760-253574/3_760804441BS | INITIAL   | 108-88-3   | Toluene                      |              | SC               | Yes               | Y           |                |                      |                       | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |                |                |
| 9       | LCS 760-253574/3_760804441BS | INITIAL   | 1330-20-7  | Xylenes, Total               |              | SC               | Yes               | Y           |                |                      |                       | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |                |                |
| 10      | LCS 760-253574/4_760804441BD | INITIAL   | 17060-07-0 | 1,2-Dichloroethane-d4 (Surr) |              | SUR              | Yes               | Y           |                |                      |                       |                        |                        |                    | percent     |                      |                |                |
| 11      | LCS 760-253574/4_760804441BD | INITIAL   | 108-88-3   | Toluene                      |              | SC               | Yes               | Y           |                |                      |                       | 0.170                  | 0.170                  | 1.00               | ug/l        | ug/l                 |                |                |
| 12      | LCS 760-253574/4_760804441BD | INITIAL   | 1330-20-7  | Xylenes, Total               |              | SC               | Yes               | Y           |                |                      |                       | 0.190                  | 0.190                  | 2.00               | ug/l        | ug/l                 |                |                |

## **Appendix C**

### **Project Schedule**

[illegible]

[illegible]





| ID  | Task Name   | Duration | Start        | Finish       | Milestone | 19 |    | 2020 |    |    |    | 2021 |    |    |    | 2022 |    |    |    | 2023 |    |    |    | 2024 |    |    |    | 2025 |    |    |    | 2026 |    |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|     |   |          |              |              |           | Q3 | Q4 | Q1   | Q2 | Q3 | Q4 | Q1   | Q2 | Q3 | Q4 | Q1   | Q2 | Q3 | Q4 | Q1   | Q2 | Q3 | Q4 | Q1   | Q2 | Q3 | Q4 | Q1   | Q2 | Q3 | Q4 | Q1   | Q2 | Q3 | Q4 | Q1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 115 | Meeting with EPA to Review TM on Alternatives Development and Screening (w/in 30 days after memo submittal) | 30 days  | Thu 10/16/25 | Fri 11/14/25 | No        |    |    |      |    |    |    |      |    |    |    |      |    |    |    |      |    |    |    |      |    |    |    |      |    |    |    |      |    |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |